POWER

Vol. 38 NEW YORK, SEPTEMBER 2, 1913 No. 10

ON TO SPRINGFIELD!

One objective: The N. A. S. E. Convention at Springfield.
One object: The Good of the Engineer.

Springfield Electric-Light Plant

By Warren O. Rogers

SYNOPSIS—This central station contains turbine units in both the old and new sections, vertical porcupine boilers supplying them with steam. Motor-driven, direct-current arc machines are used for street lighting. The residential lighting rate is nine cents per kilowatt-hour; the day load exceeds the night load.

❖

Visiting engineers to Springfield, Mass., should not fail to visit the power plant of the United Electric Light Co., at the foot of State St. It is a strictly business proposition, void of frills and show units, and, although the plant, as it stands today, is the result of additions to the generating units, from time to time, it is attractive and well designed.

Years ago the original plant consisted of reciprocating units and belt-driven line shafting from which the generators were driven. This arrangement was modern at the time, but would make a strange contrast with the latest design of units found in service there today.

There are many interesting events connected with the history of the plant in connection with the changes which have taken place and also as to the attitude the officials have taken regarding their relations with the public. First, at the head of the company are local men, who have a pride in the welfare of the city, as well as a business interest in the plant in which they have invested their money. The slogan of the company is, "Give everybody the best there is." Result: there is an absence of scathing, condemning articles by the newspapers decrying the actions of the company, the customers are satisfied, the service is good and the rates low for central-station service. For instance, the residential lighting service is charged nine cents per kilowatt-hour and manufacturing establishments using power circuits are charged much less.

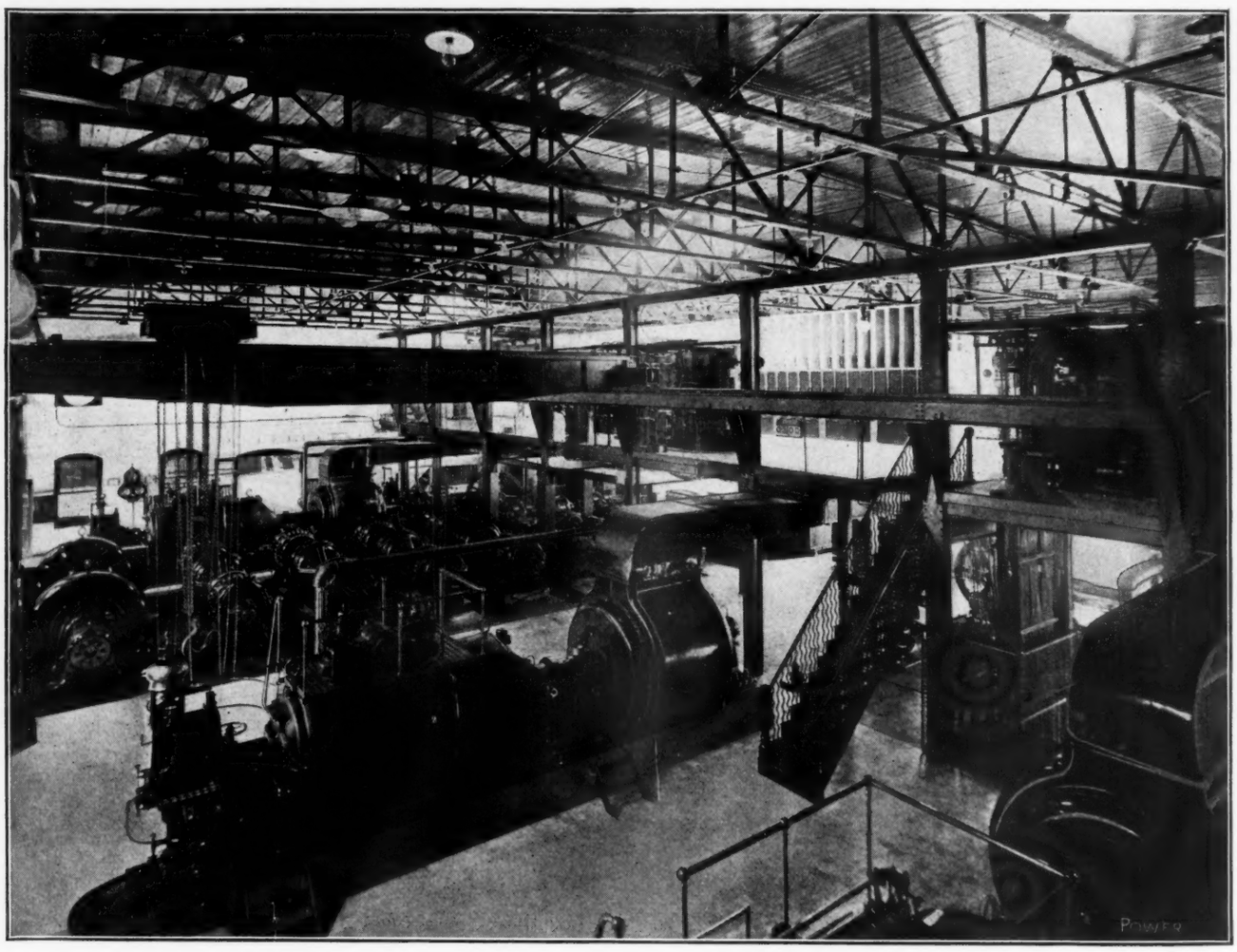


Fig. 1. Old Turbine Room, Arc Machines and Switchboard Gallery

No labor troubles arise to interfere with the harmonious operation of the plant, mainly because the men are treated as men and because those in authority have worked themselves up from humble positions to those of responsibility, and knowing what work is to be done, how it feels to work in the everyday grind of power-plant operation, and believing a man is worthy of his hire, are some of the reasons why the fifty-odd men employed about the plant are satisfied with their positions and with their superiors.

Viewing the plant from the exterior, from the State

St. approach, one sees a rather low red brick building, through the double doors of which a glimpse of some of the machines, of what is now termed the old plant, is seen. At the right is a small brick building in which is the office of Chief Engineer Walter H. Damon, and at the rear of which is a well equipped machine shop. At the left is the new boiler room, separated from the new turbine room by a brick wall. At the rear of the office and adjoining the old turbine room is the old boiler room; the boilers of which are used during the winter season only, but can be fired up at any time, if necessary.

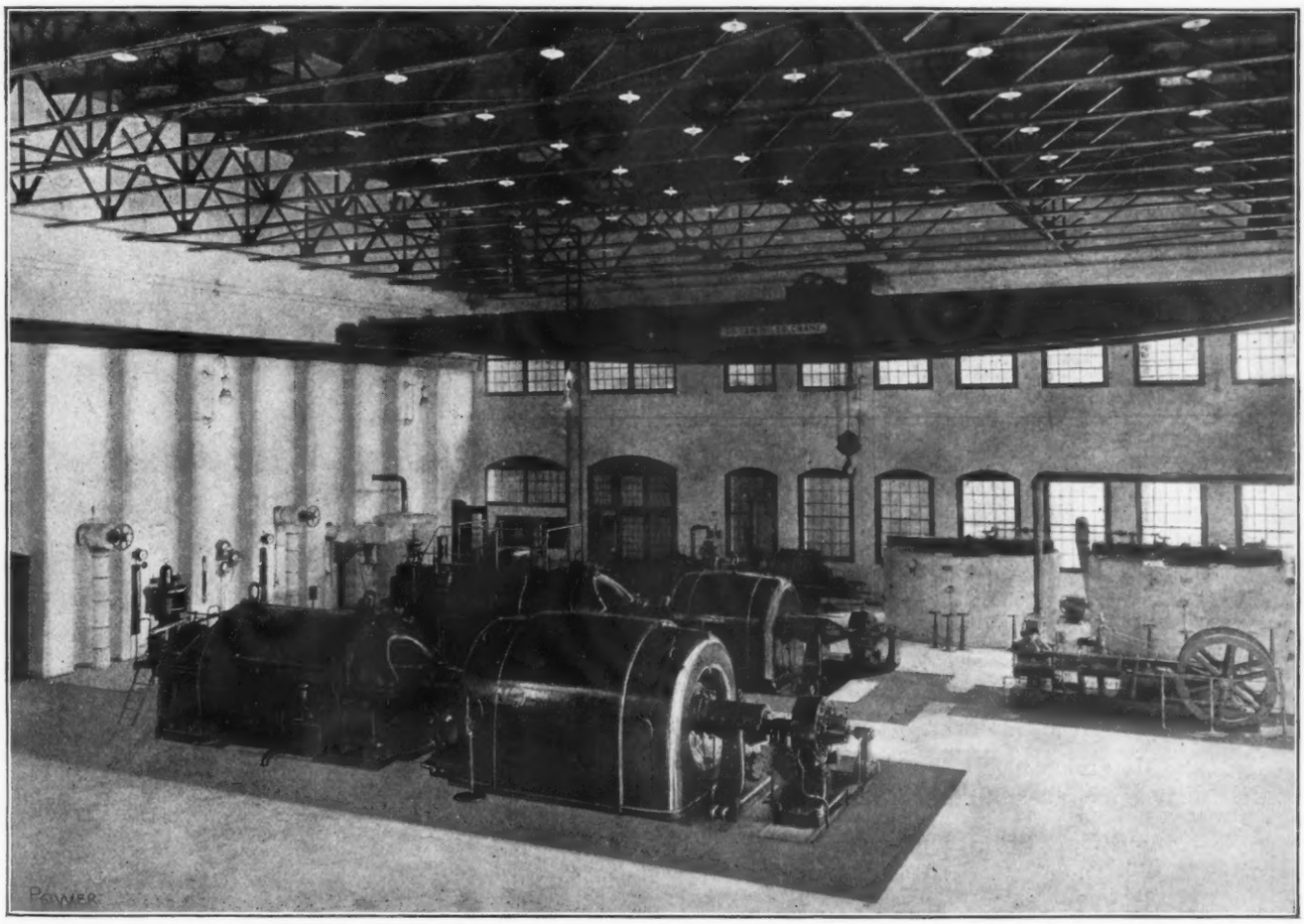


FIG. 2. TWO OF THE THREE TURBINE UNITS IN THE NEW TURBINE ROOM

As an inspection of the plant is in order, suppose we begin with the old part and go through it with the idea of noting the size and equipment of the plant that furnishes electricity, without competition, to the population of a city of approximately seventy-six thousand.

OLD BOILER ROOM

In the old boiler room there are eight 400-hp. porcupine boilers. Dutch-oven furnaces and mechanical stokers are used on all of the boilers in both the new and old boiler rooms. The old boilers are set in two rows and in two batteries, each of four boilers, with a firing aisle between.

Coal is delivered to the stoker hoppers by a belt conveyor, a double discharging chute distributing the fuel to the hoppers of both rows of boilers. Each boiler in each row is connected to a 12-in. steam main by a 5-in. lead. These two steam mains supply steam to the turbine in the old plant.

OLD TURBINE ROOM

Upon entering the old turbine room, Fig. 1, one sees three 1000-kw. steam-turbine units. Two are on the side of the room nearest the boilers, the third is next to the wall dividing the two turbine rooms. No. 2 turbine was the first turbine used in the city and was installed in 1904, and has never cost a cent for repairs. It was among the first built by the manufacturers, being No. 98. Nos. 1 and 3 units were operated a year later. The generating end of each turbine is a 1000-kw., two-phase, 60-cycle, 7200-volt generator; the speed of each is 1800 r.p.m.

The vertical jet condensers are in the basement, with the steam cylinders protruding above the turbine-room flooring. The exhaust pipe of No. 1 unit is fitted with a hydraulic-operated valve, the other two exhaust pipes with motor-operated valves. The condenser of No. 1 is at the generator end, as a necessity, on account of the floor area required in the basement, which was restricted at this machine by the wall on one side and the adjoining turbine foundation on the other. The condensers for the other two turbines are at the sides of the steam end. The three dry-vacuum pumps are on the turbine-room floor.

The turbine generators were originally of the open-

casing type, but have since been fitted with air ducts leading from the top of the casing out through the river side of the building, as shown in Fig. 1.

Exciter Units

There are three engine-driven exciter units. One near No. 1 turbine, the other two at the generator end of No. 3 turbine, next to the wall between the new and old tur-

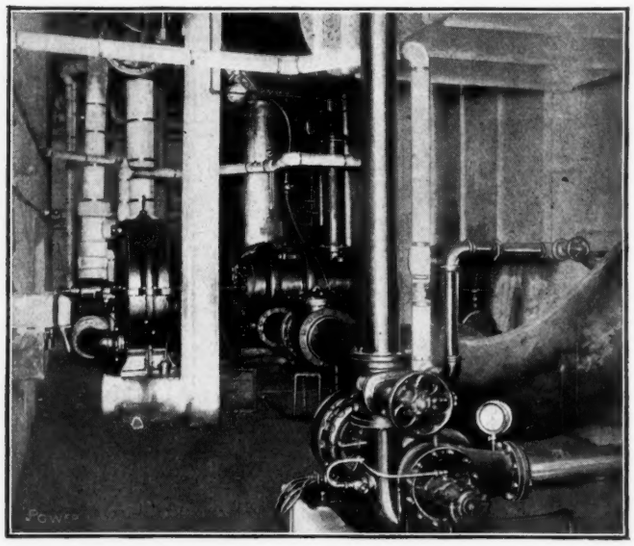


Fig. 3. One of the Condenser Outfits

bine rooms. The direct-current generators are each of 25-kw. capacity. The new turbine generators are excited by self-contained, direct-current generators mounted on an extension of the turbine shaft, as illustrated in Fig. 2. Each delivers 125-volt current. One is of 35- and the other of 50-kw. capacity, and they are attached to 2500- and 4000-kw. turbines, respectively.

Arc-Lighting Units

In the old turbine room there is a 67-hp. induction motor directly connected to a 40-kw. direct-current, 125-

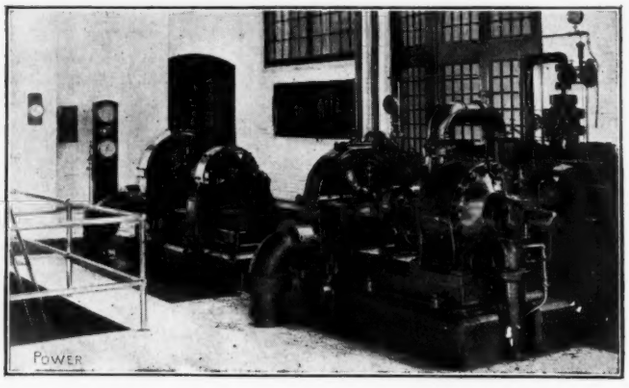


Fig. 4. Turbine-Driven Generator and Centrifugal Pump

volt generator, used to supply energy to a few 110-volt motors throughout the city.

Between Nos. 2 and 3 turbines are the motor-driven arc-light units. There are four 154-hp. induction motors, each connected to two one-circuit direct-current 10,000-volt arc machines, at a speed of 500 r.p.m. There are also six 125-hp. induction motors coupled to 12 direct-current, 8000-volt arc machines at 700 r.p.m. The flexible couplings are made with two flanges holding lengths of round rubber which fit into round spaces. They are prevented from working out endwise by flat plates, and from the top by the overlap of the rim face.

Two 500-kw. rotary converters supply manufacturers with current for motor circuits at 600 volts, at a speed of 600 r.p.m. These units are at the State St. side of the station between the arc machines and the marble arc-lighting plug switchboard. Rubber mattings are placed about these and the arc machines as a precaution against the operator slipping, while working about them, and to eliminate as far as possible danger from electric shock.

New Turbine Room

There are three turbines in the new turbine room, Fig. 2, two of which are shown. One is a single-flow unit; the one in the foreground of Fig. 2 and the new unit are of the double-flow type. They have a capacity of 2500, 4000 and 6000 kw. at a speed of 1200, 1800 and 3600, respectively.

Two of the three turbine units are running and the third is practically ready to operate. Fig. 2 gives a view

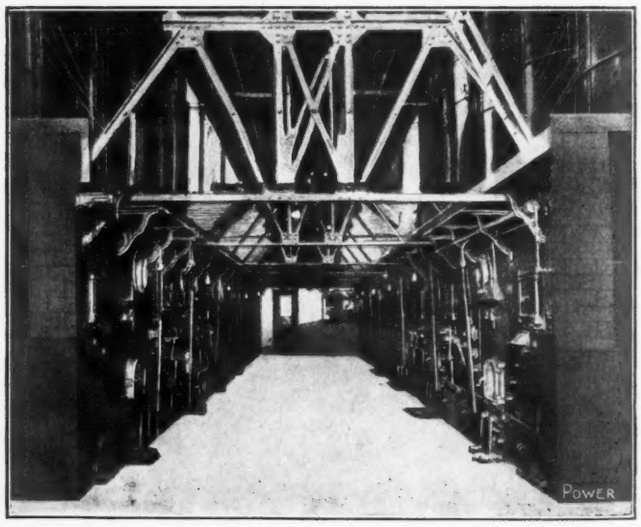


Fig. 5. New Boiler Room, Showing Original Boilers

of the room, including a dry-air pump, the two boiler-feed pumps and the water-filtering tanks. The small turbine exhausts to a 10-in. jet condenser having a motor-driven circulating pump. The dry-air pump on the turbine-room floor is connected with this condenser. The two large turbines are operated in connection with two 18-in. Leblanc condensers, both located in the basement beneath the steam end of the turbine. One of the condensers is shown in Fig. 3.

There is at the far end of the new turbine room, an auxiliary turbine-driven, direct-current, 50-kw., 125-volt generating set that can be used for exciting purposes or for station lighting, if either becomes necessary. The turbine-driven 5-in. three-stage centrifugal pump, shown, is used for boiler feeding, and a second unit, which has been installed in place of the duplex pump shown, furnishes a second unit, consisting of a turbine-driven 6-in. three-stage centrifugal pump. These units are shown in Fig. 4.

Water for condensing purposes and for boiler feeding is taken from the Connecticut River, the circulating water discharging to the river after passing through the condensers. The suction lines of the condenser pumps are fitted with twin strainers between the pump and river. They are necessary on account of leaves, grass and other floating débris being drawn into the suction line and

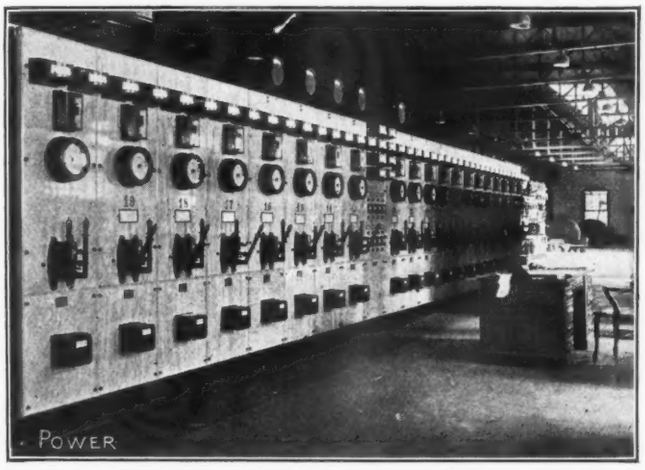


FIG. 6. MAIN DISTRIBUTING SWITCHBOARD

which would otherwise restrict the flow of condensing water through the condenser. On the new turbine condenser suction line multiple strainers are used.

All boiler-feed water is pumped from the river into two filtering tanks which have a capacity of 460 gal. of water per min. The water is filtered in one tank and is taken from the storage tank by the feed pumps.

NEW BOILER ROOM

The new boiler room, Fig. 5, has twelve 400-hp. porcupine boilers and four more of the same type and horsepower are being installed. They have mechanical stokers and carry a steam pressure of 150 lb. The boilers are placed in two rows with a firing alley between, above which a belt conveyor runs, delivering coal from the yard or coal cars as the supply dictates.

Fuel is unloaded from railroad cars, either into a hopper above the crushing rails, or is dumped into a coal pocket in the rear of the boiler room by a grab-bucket hoist, which runs on a track above the same. The conveyor delivers coal to the stoker hopper by gravity through a discharge chute.

Ashes from the stoker drop into an ashpit and are conveyed to an ash bin on the outside of the building, from where they are carted away free of charge by the city for filling-in purposes.

The installation of the four new boilers gave the observer a better idea of their construction than could be obtained by other means. An examination of the standpipe showed that the vertical seam is lap welded, as are also the tubes, and that braces and staybolts are conspicuous by their absence. The standpipe of each boiler rests on a simple foundation, unsecured by any fastenings, and the entire boiler can expand or contract at will without strain to itself or to the brick setting. As practically one-third of the volume of the boiler is devoted to steam space, and as the entire surface is exposed to the heated gases, this space above the water line acts as a superheater.

All tubes are staggered and act as baffles to the gases and eliminate the necessity of putting in brick baffle walls. The weight of water in the standpipe tends to force the tubes full of water, and when the boiler is working there is a descending column of water and an ascending column of steam mixed with water in the standpipe. At the same time there is an ingoing and an outgoing stream in the tubes.

A 16-in. steam header is between the new turbine room and the nearest row of boilers, on the boiler side of the wall separating them. Each boiler is connected to the header by a 6-in. lead, having long-radius bends. All high-pressure steam piping has Van Stone joints. The turbines are fed from the main header through pipe lines coming in through the wall and fitted with an angle-stop valve on the turbine-room side of the wall. The pipes then drop through the floor and connect with the turbines from the basement. All pipes are covered with a suitable covering.

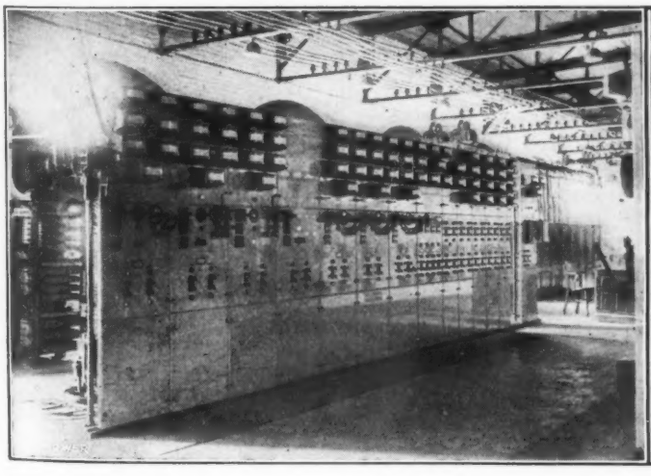


FIG. 7. GENERATOR SWITCHBOARD

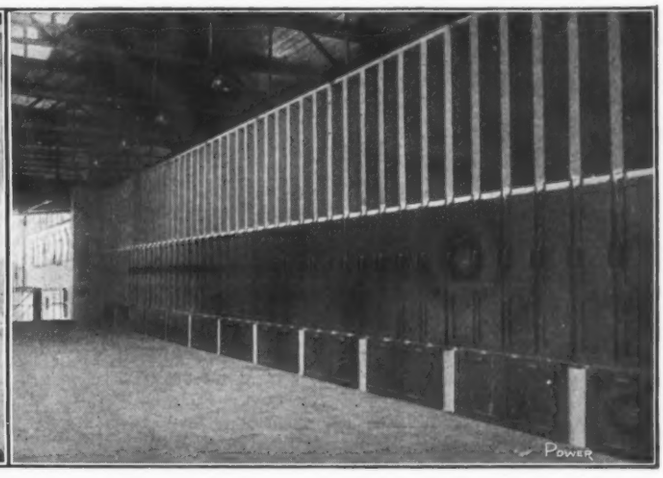


FIG. 8. BUSBAR COMPARTMENTS

SWITCHBOARDS

All switchboards, with the exception of the arc plugboard, are in the old turbine room on a balcony on the

river side of the plant. The balcony is reached by a stairway placed about opposite the entrance doors. The switchboards include one of six panels, used for controlling the rotary converters. It is shown at the far end of Fig. 6. On the main distributing board, of 21 panels, shown in the foreground, are mounted the necessary switches, wattmeter and watt-hour meter. The generator board, Fig. 7, contains 14 panels, six for the generators, the remainder being devoted to the exciter, central, power and lighting circuits.

All high-tension busbars and solenoid-controlled oil switches are placed in concrete compartments, Fig. 8. Eventually all overhead wiring on the balcony will be removed, which will add to the appearance of the gallery and to that of the exceptionally well designed switchboards. A synchronizing dial is placed on both sides of the wall separating the turbine rooms, in sight of the operators and switchboard attendants.

Notwithstanding the many changes which have been made, during the past 20 years, the layout of the various units has been made with an eye to saving floor space without permitting a jumbled appearance, as indicated by Figs. 1 and 2.

Because of the numerous windows in the turbine rooms they are both light and comfortably cool, even on a hot summer's day, and as the plant is built on the bank of the river, the windows on that side of the building can be open without the annoyance of dust blowing in upon the machinery.

For June of this year the average lighting load was 1,000,348 kw.-hr. for the steam plant, which is run in connection with two hydro-electric installations, which have a total capacity of 3000 kw. The day load of the steam plant, which is larger than the night load, is approximately 5000 kw.

PRINCIPAL EQUIPMENT OF THE UNITED ELECTRIC CO.'S POWER PLANT, SPRINGFIELD, MASS.

No.	Equipment	Type	Purpose	Kv.-a.	Kw.	Phase	Cycles	Volts	Amp.	Hp.	R.p.m.	Steam Pressure Lb.	Size	Manufacturers
24	Boilers	Porcupine	Steam	....	....	....	....	.....	....	400	....	150	.....	Porcupine Boiler Co.
24	Stokers	Murphy		....	....	....	....	.....	....	....	....	....	.....	Murphy Iron Works.
3	Turbines	Single flow	Main units	....	1000	....	....	.....	....	....	1800	150	.....	Westinghouse Machine Co.
1				....	2500	....	....	.....	....	....	1200		.....	
1				4000	....	....	....	.....	....	....	1800		.....	
1		Double flow		6000	....	....	....	.....	....	....	3600		.....	
1	Turbine										2800			
1		Single stage	Circ. pumps	....	....	....	....	.....	....	....	2400		.....	Terry Steam Turbine Co.
1			Auxiliary unit	....	....	....	....	.....	....	85	2800		.....	
3	Generators			....	1000		....	7200	5500	....	1800	....	.....	
1		Alt. current	Main units	....	2500				....	....	1200	....	.....	
1				4000	....	2	60	5500	....	....	1800	....	.....	
1	Generator			6000	....				....	....	3600	....	.....	
1			Exciter	....	35	....	....		280	....	1200	....	.....	Westinghouse Electric & Mfg. Co.
1		Direct curre't		....	50	....	....		400	....	1800	....	.....	
1			Power circuit	....	40	....	....	125	320	....	850	....	.....	
3	Generators		Exciters	....	25	....	....		200	....	350	....	.....	
4	Generators	Constant current	Arc circuits	....	....	....	....	10,000	5	....	500	....	.....	
6				....	....	....	....	8,000		....	700	....	.....	
3	Engines	Single acting	Exciters	....	....	....	....	.....	....	....	350	150	8½x8"	Westinghouse Machine Co.
4	Motors	Induction	Arc gen	....	....	2	60	2300	40.5	154	500	....	.....	General Electric Co.
6								2800	25.	125	700	....	.....	
1	Motor		Circ. pumps					2400	21.	35	450	....	.....	
1			Generator					2200	....	61	850	....	.....	Westinghouse Electric & Mfg. Co.
1	Generator	Direct curre't	Auxiliary	....	50	....	....	125	400	....	2800	....	.....	Crocker-Wheeler Co.
3	Condensers	Jet	Turbines	....	....	....	....	.....	....	....	....	....	.....	Deane Steam Pump Co.
2		Leblanc		....	....	....	....	.....	....	....	....	....	18"	Westinghouse Machine Co.
1	Condenser	Jet		....	....	....	....	.....	....	....	....	....	16"	Deane Steam Pump Co.
3	Pumps	Dry air	Condensers	....	....	....	....	.....	....	....	....	....	10x22x18	
2	Converters	Rotary	Power	....	500	2	60	600	834	....	600	....	.....	Westinghouse Electric & Mfg. Co.
1	Pump	Dry air	Condenser	....	....	....	....	.....	....	....	....	150	12x22x18	Alberger Pump & Condenser Co.
1		Three stage	Centrifugal	....	....	....	....	.....	....	....	2800	....	4"	Jeansville Iron Works Co.
1				....	....	....	....	.....	....	....	2400	....	5"	Alberger Pump & Condenser Co.
4	Strainers	Twin	Suction pipes	....	....	....	....	.....	....	....	....	....	.....	Elliott Co.
2		Multiple		....	....	....	....	.....	....	....	....	....	.....	Lagonda Mfg. Co.
2	Filters	Open tank	Feed water	....	....	....	....	.....	....	....	....	....	.....	New York Continental Jewell Filtration Co.
1	Crane	Motor opera'd	Turbine room	....	....	....	....	.....	....	....	....	....	25 ton	Niles-Bement-Pond Co.

A railroad cut through coal on the new construction work of the Louisville & Nashville R.R. in the northern part of Alabama has been converted into a profitable mine by the contractor, who is selling the coal to his neighbor contractors.

Efficiency of a Steam Ejector

By F. M. Thomas

Many ejectors for raising water in small quantities are used and while they are known to be "steam eaters," it is not generally appreciated how inefficient they really are. A rough test on a 1½-in. brass ejector of good make and in good repair, gave these results.

Water per minute, 33 gal. or 274 lb. $= W$

Temperature of water in well was 112 deg. $= t$

Temperature of water delivered was 142 deg. $= T$

Water was raised 23 ft.

Total lift including friction taken as 25 ft.

Steam pressure assumed at 80 lb. at the ejector.

The water delivered, W, includes the weight of condensed steam. The water removed from the well is found by an easily derived formula,

$$w = \frac{H - T}{H - t} W$$

where H is the total heat of the steam at 80-lb. pressure, or 1180. We then have

$$w = \frac{1180 - 142}{1180 - 112} 274 = 266.3\ lb.$$

The weight of steam required is of course the difference of W and w or

$$274 - 266.3 = 7.7 \text{ lb.}$$

Water horsepower is

$$\frac{266.3 \times 25}{33{,}000} = 0.202$$

This is useful work.

Weight of steam per hour is

$$60 \times 7.7 = 462 \text{ lb.}$$

Steam per horsepower per hour is

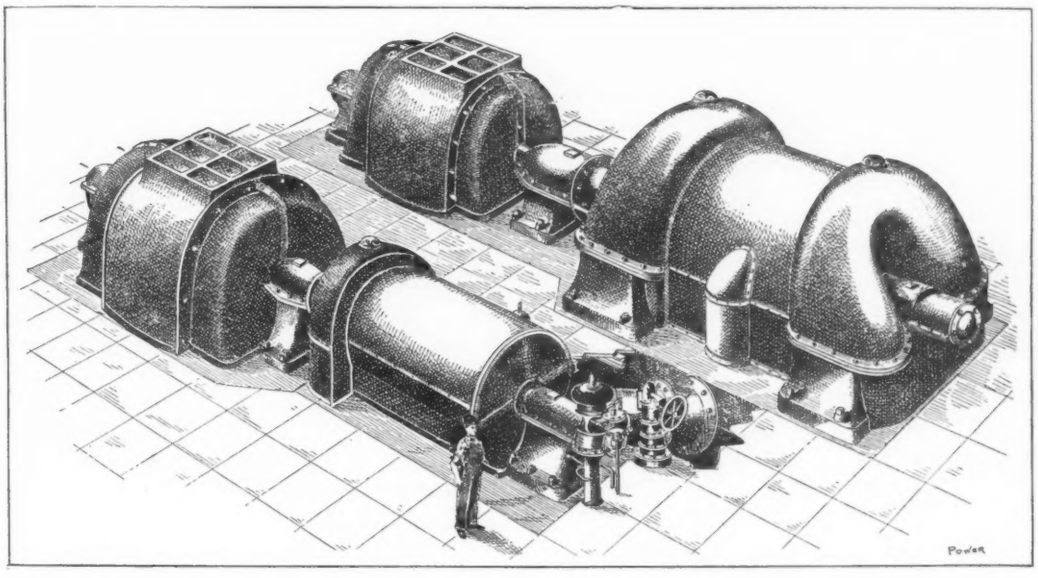
$$\frac{462}{0.202} = 2287$$

This indicates that the use of ejectors is not warranted except where small quantities of liquid are occasionally to be lifted.

New York's Largest Turbine

SYNOPSIS—A 30,000-kw. reaction turbine divided into two elements, the high-pressure running at 1500 r.p.m. and the low-pressure element at 750 r.p.m. There will be two generators, each running at a different synchronous speed.

Not to be outdone by Chicago in turbines of large capacity, the Interborough Rapid Transit Co., of New York City, has recently awarded a contract to the Westinghouse Machine Co. for a horizontal turbine of 30,000-kw. capacity. The feature of this particular unit will be its division into two turbine elements; the high-pressure element being a single-flow turbine, operating at 1500 r.p.m., and the low-pressure element being a double-flow turbine, operating at 750 r.p.m. The machine is of reaction type throughout, and comparatively low blade speeds are involved. It will be installed at the company's Seventy-fourth St. station.



30,000-Kw. "Cross-Compound" Turbine for the Interborough's Seventy-Fourth St. Station

The scheme of employing two turbine elements having the steam pass serially through them is not new. A number of such units of from 1000- to 2000-kw. capacity were built by the Westinghouse Co. in 1901. This construction has again come to the front in the case of the English-built Parsons turbine, purchased by, but not yet delivered to, the Commonwealth Edison Co., of Chicago. It is new, however, to employ high-pressure and low-pressure elements driving separate generators, each at a different synchronous speed.

When any turbine is designed for high expansion ratios the engineer is confronted with the problem of having to deal with relatively minute volumes of steam at the high-pressure end and enormous volumes at the low-pressure end. It is therefore evident that if the high-pressure portion of a turbine may be operated at twice the rotative speed of the low pressure, this problem is largely eliminated.

Besides the gain from using different speeds, the division of the turbine into two separate elements has other advantages. The temperature range in either element is reduced. A sufficient number of stages may be introduced to give high hydraulic efficiency without any mechanical difficulties, such as increased length between bearings, etc. Some little advantage is also to be gained by separating the water between the two turbine elements which has been precipitated in the steam expansion. Either element is more reliable and simple because of its smaller size. Doubtless there is some loss of efficiency due to the employment of two generators instead of one at twice the capacity, but this is more than overbalanced by the gain in economy, due to the two elements operating at different speeds. For want of a better term these units have been called "cross-compound" machines.

It is planned to carry a vacuum of 29 in. on the turbine and 120 deg. of superheat. The steam-consumption guarantee provides for 75.75 per cent. of the energy available in the expanding steam materializing as electrical energy at the terminals of the generators.

Igard Water-Glass Shield and Reflector

The Igard water-glass shield and reflector is designed to protect the firemen from flying glass and escaping water and steam, when working in the proximity of a water column. It consists of four split castings, which clamp to the bodies of the gage-glass cocks. These castings are grooved, allowing the shield, which is made in two parts, to travel in their respective grooves.

The shield, which is manufactured by the Gardner Grate Co., 27 Burgess St., Boston, Mass., when open, allows a view of the gage-glass from any position in the room in front of the boilers. When closed, two-thirds of the circle is covered, leaving one-third open to the rear for the escape of the flying glass, steam and water.

The inside of the shield is of flat-white enamel, with a red line down the center, which enables the attendant to see the waterline instantly. The apparatus is finished in brass or nickel, and is made to fit any water column.

Power Plant of Springfield Street Railway Co.

By W. O. Rogers

SYNOPSIS—This power plant supplies electrical energy to operate approximately 175 miles of street railway. The generating units are in two rooms and consist of vertical and horizontal cross-compound engines, directly connected to 600-volt, direct-current generators. Water-tube boilers are used, with mechanical stokers.

Next to the central-lighting plant, the power plant of the Springfield Street Ry. Co. is the largest in the City of Springfield, Mass. This station supplies electrical energy for approximately 175 miles of track. It is said that a greater percentage of the inhabitants patronize the trolley lines than in any other city in the United States, based on the population of each.

As is frequently the case, this power plant is composed of two sets of installations, those of the original boilers and engines and a newer section in which larger and later-designed units have been installed.

The plant is built near the Connecticut River, but is separated from it by the tracks of the N. Y., N. H. & H. R.R. Condensing water, also boiler-feed water, can be had for the pumping. The older section of the plant is a comparatively low brick building, in which are housed eight water-tube boilers, which carry 150-lb. steam pressure. These boilers are placed in a boiler room adjoining the end of the old engine room, Fig. 1, and are set with the rear ends toward the wall separating the boiler and engine rooms. Six of the boilers are set on one side of a brick stack which is 175 ft. high, with an inside diameter of 8 ft. The two remaining boilers connect with the stack from the opposite side. The boilers are fired by mechanical stokers, six of which are driven from a shafting suspended above the boiler setting and driven by a vertical steam engine. The two other stokers are driven by a separate engine and shafting.

Coal and Ash

Ashes are removed by hand from the ashpit into an ash cart and carried on an elevator to a level with the ash bin, built on the outside of the new boiler house. The ashes are dumped into the bin and are carted away by the city free of cost.

Coal is unloaded from railroad cars into a hopper, built under a spur track, and is elevated to a tower and then dumped into a small industrial coal car, and after weighing is carried to the coal bin above the boiler in the new boiler house. A chute permits of dumping fuel into a bunker in the yard from which it is admitted

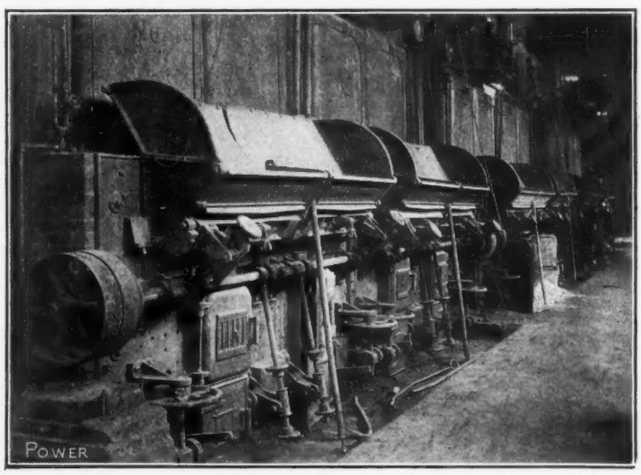


Fig. 1. Boilers in Old Boiler Room

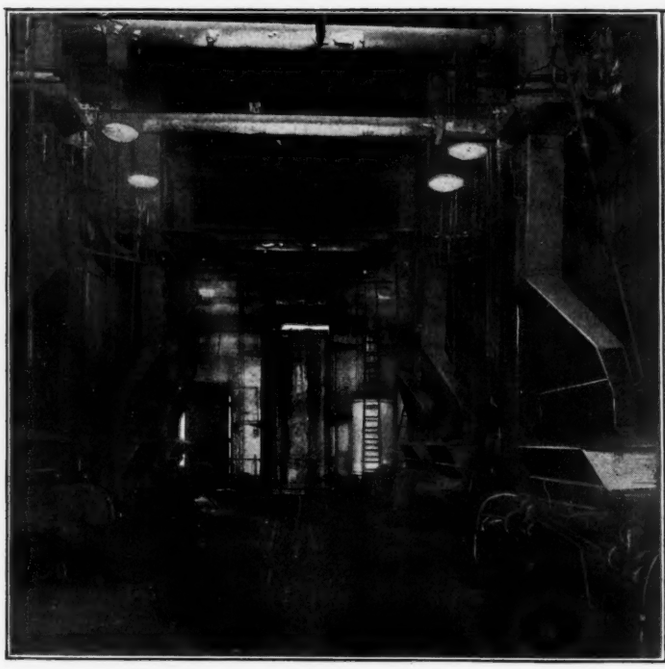


Fig. 2. New Boiler Room

Fig. 3. One of the Vertical Engines

to the old boiler room through openings in the wall facing the boilers.

New Boiler Room

In the new boiler room, Fig. 2, there are eight 350-hp. water-tube boilers with a working pressure of 150 lb. They have gravity underfeed stokers, driven by chains and sprockets indirectly from four sets of turbine-driven blowers. The blowers are belt-connected to line shafts which are suspended from the basement ceiling. By this arrangement as the speed of the blowers is reduced with an increase of steam pressure, the feeding of fuel to the furnace is retarded. With a decrease of steam pressure the speed of both fans and stokers is increased.

Ashes are removed from the ashpits into an ash can in the basement and are then hoisted on an elevator to the ash bin already mentioned.

All blowoff pipes are connected to one large blowoff main back of each row of boilers. The pipes are placed beneath the concrete flooring with the valve stem of the blowoff valves in a vertical position, the handwheels only coming above the flooring.

These boilers are connected by smoke flues from the back end to a 225-ft. brick stack with a 10-ft. inside

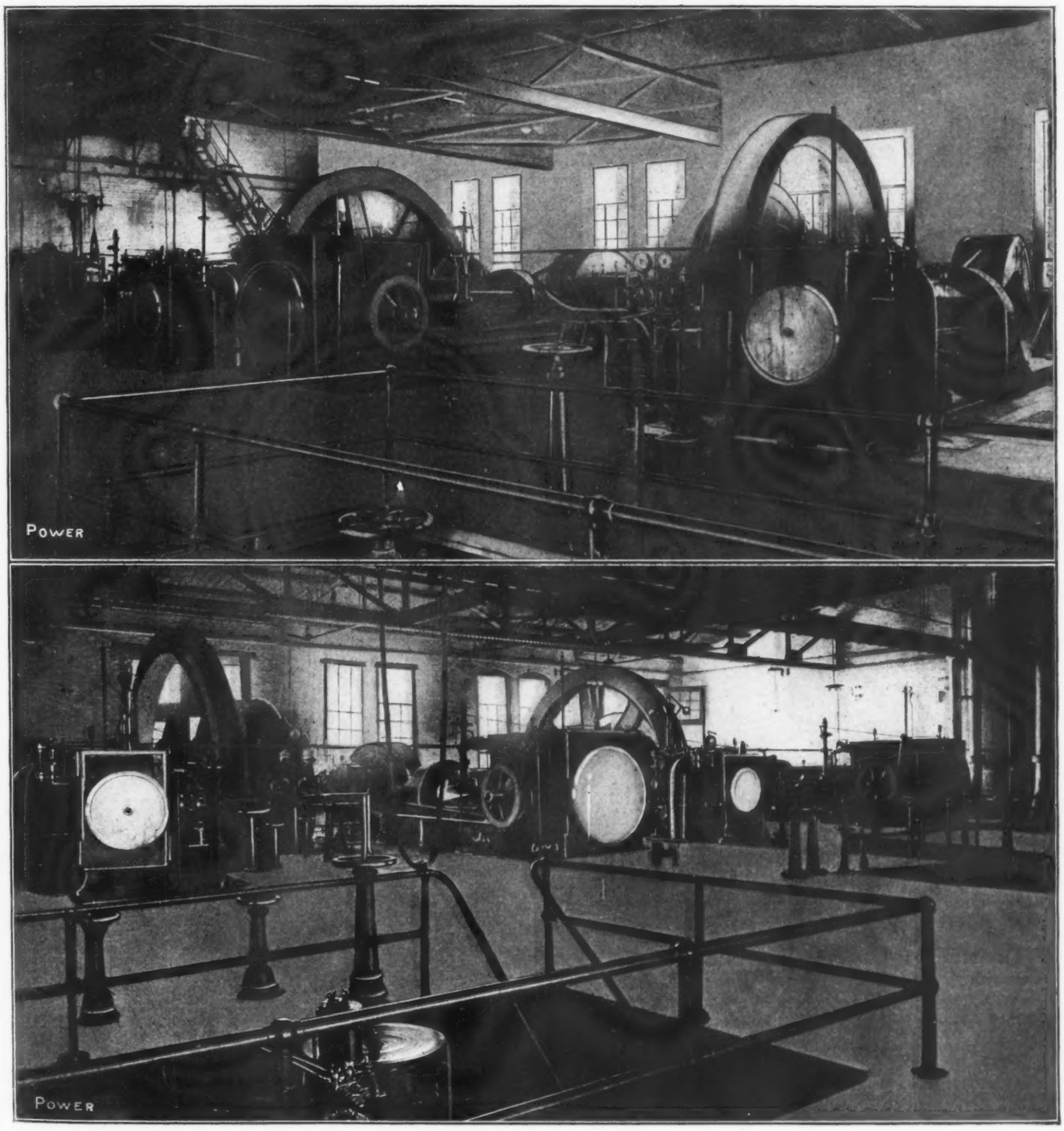


Fig. 4. Two Views of the Old Engine Room

diameter. It is built at the end of the boiler house at the end of one row of boilers, which necessitates running one smoke flue across the boiler room. The gases of combustion pass through two economizers on their way to the chimney.

Engine Rooms

In the old engine room, Fig. 4, there are four cross-compound engines running condensing. Each is directly connected to a multipolar, 600-volt generator, running at 80 r.p.m. These units are placed two on each side of the engine room, leaving the floor space in the center available for condenser pits and stairways leading to the basement. All engines run condensing and exhaust steam pipes are attached to four 12 and 25 by 18-in. jet condensers. An 18 and 44 by 24-in. jet condenser operates with each of the two large vertical cross-compound engines in the newer part of the plant. One of the units is shown in Fig. 3. These four-valve engines have 38 and 76 by 60 and 38 and 78 by 60-in. cylinders. Each is directly connected to a 600-volt railway generator at 75 r.p.m.

Two rotary converters are operated in the old engine room. The alternating-current side is 25-cycle, 380 volts at 500 r.p.m., the direct-current being 60 volts and 500-ampere capacity.

PRINCIPAL EQUIPMENT OF THE SPRINGFIELD STREET RAILWAY CO.'S POWER PLANT.

No.	Equipment	Type	Purpose	Volts	Amp.	Hp.	R.p.m.	Steam Pressure Lb.	Size	Manufacturers
88	Boilers	Water Tube	Steam Generators	....	....	250	....	150	....	Babcock & Wilcox Co.
8	Boilers	Water Tube	Steam Generators	....	....	350	....	150	....	Babcock & Wilcox Co.
8	Stokers	Acme	Boilers	....	....	....	....	....	....	Harrisburg Foundry & Mach. Co.
4	Stokers	Taylor	Boilers	....	....	....	....	....	....	American Engineering Co.
2	Engines	Corliss	Main Units	....	....	....	80	150	....	
4	Economizers	Green	Feed Water	....	....	....	....	....	....	Green Fuel Economizer Co.
4	Generators	Direct Current	Main Units	600	1333	....	80	....	....	
1	Condensers	Jet	Corliss Engines	....	....	....	....	150	12x25x18"	International Steam Pump Co.
1	Condenser	Jet	Vertical Engines	....	....	....	....	150	18x44x24"	Blake Pump & Condenser Co.
1	Condenser	Jet	Vertical Engines	....	....	....	....	150	18x44x24"	Warren Steam Pump Co.
1	Engine	Vertical Comp.	Main Units	....	....	....	....	....	38x76x60"	Westinghouse Machine Co.
1	Engine	Vertical Comp.	Main Units	....	....	....	75	....	38x78x60"	McIntosh & Seymour Co.
1	Generator	Direct Current	Main Units	600	3478	3300	75	....	....	General Electric Co.
1	Generator	Direct Current	Main Units	600	3478	3300	75	....	....	General Electric Co.
2	Converters	Rotary	Alt. Current	600	500	.....	500	....	....	General Electric Co.
2	Converters	Rotary	Alt. Current	380	500	.....	500	....	....	General Electric Co.

Technical Extra Illustration

By A. L. Haas

A friend of the writer's greatly interested in literature, uses a simple scheme for classifying his quite considerable knowledge about books. He takes a number of literary journals and papers from which articles he is particularly interested in are cut out as soon as read. Loose clippings, being especially difficult to find when wanted, he pastes at appropriate places in his books. He has a number of crowded shelves, the contents of which bear mainly on a definite period and a particular phase of literature.

As an intimate of his, the writer has been lent many of his treasures. Money simply could not buy them, they are annotated, marginally penciled, interleaved and underlined. Parallel passages are easy to compare. The inserted clippings and illustrations amplify the text enormously. Every book this friend possesses has more than one short biography of the author stuck in.

If a criticism by a reviewer appears in a current periodical or newspaper about any book this man possesses, it is pasted somewhere in that book. If an author mentions a particular place, a magazine illustration or a postcard, if procurable, is stuck in.

This practice was started as a consequence of reading an article on grangerizing or extra illustration, and it was decided that clippings on any subject matter are as relevant as pictures—sometimes more so, so he uses both.

The average engineer owns a good many technical books, at the same time he is forced to scrap quantities of reading and advertising matter in the current technical publications. Why not preserve the best of the latter in extra-illustrating the technical books?

In most all of such books the publisher has left a splendid scrapbook at the end in a catalog of other publications. These, with the usual flyleaves, and excluding contents and index, leave available several pages to use, besides the numerous spaces at ends of chapters.

Books are greatly enhanced in value by extra illustrations and clippings. Take one on steam engines for an example of the method. The author has made a selection of types, each machine illustrated being typical of its particular class which does not exhaust the field. From the advertising pages of current periodicals a number of illustrations can be taken to amplify the text. If an engine is referred to but not shown, the next picture of it that is met with can be stuck in along one edge at the most convenient place. Of great advantage is the fact that the material compiled by the author is sectionalized and carefully arranged by him. No thought is needed on the part of the extra-illustrator as to the arrangement; it is already arranged.

Discrimination is needed especially in the matter actually pasted in, but obsolete matter is easily removed without destroying the actual book, if the clippings are pasted along one edge only to the margin of the page.

It is even possible to graft essential matter from one book into another, making two volumes into one, where only a small amount of relative importance is found in one of the two books of similar subject.

The books on the shelf form a convenient receptacle for the loose pieces of paper, and even when loose they are where they belong. When inclination and leisure serve, the slips are already in place, need no sorting out, and a few minutes with a paste brush suffice to fix them permanently.

As a variation or extension of pasting in, pockets can be formed of glazed linen and glued inside the covers at either end with their mouths to the back of the book.

Books of quite trivial value when extra-illustrated with taste and care with prints; even if the pictures are not particularly scarce or rare at the time of such amplification, have realized, after a lapse of years, quite considerable prices to collectors. It is possible that technical books thus treated may be found to have an added value some time in the future.

Purchasing or Making Power

By Henry D. Jackson

SYNOPSIS—A case is cited where the operating costs are much too high, the labor exceeding the fuel cost. A comparison of manufactured and purchased power favors the isolated plant.

The question of purchasing or making their own power is constantly before engineers who are confronted with the statements of power-company representatives, as to their reasons why power should be purchased from them rather than generated in the plant under consideration. One of the latest arguments coming to my attention is given herewith.

There was a plant whose product demanded a 24-hour service. The average motor load would approximate 75 kw.; the maximum, 100 kw. The power-plant engineer stated that a duplicate outfit of 100 kw. normal capacity should be installed to insure continuous service instead of two 75-kw. machines, which could easily handle this load, as these machines are capable of handling a 50 per cent. overload for two hours and could handle a 33 per cent. overload continuously.

There are many plants where 24-hour service is demanded for six days each week with a single unit, and no more trouble is experienced than would ordinarily be had with a duplicate unit. It only requires careful attention and good apparatus. In many cases a duplicate unit is not necessary; but, if so, it is not necessary to duplicate the boilers and other apparatus.

According to the figures obtained, the labor for the 200-kw. plant cited is $5840. One man could act as both engineer and fireman. The coal figures $5500 per year and the labor exceeds the cost of coal. The total cost is $14,390, including the fixed charges on the generating apparatus.

In the case of purchased power, the total charges against the plant are the cost of power, which at 1½ cents per kilowatt hour is equal to $9750, an apparent saving of $4640. Against this purchased power there is no charge for superintendence and care of the equipment, which is evidently included in the labor charge when power is generated. Since the motor equipment is the same in both cases, no charge is made against this in making the comparison. But in either case heat will be required, so that a fireman would be necessary during the winter months and his labor charge should be added in the case of purchased power, also the heating coal.

In addition to this, there are the boilers and the fixed charges on these, so that this $4640 does not represent a net saving, but a saving of a fictitious character, or the difference between the cost of power furnished in one case, and the cost of power, superintendence and heat, with all fixed charges included, in the other case; i.e., with the plant generating its own power.

So far as possibility of interruption to the service is concerned, it would be necessary to install a duplicate bank of transformers and other outside protection, to insure the purchaser against loss of power from the lighting company, as the chances of the generator or engine unit giving out are no greater than are the chances of the transformers being burned out from some cause.

If a plant averaging 75-kw. capacity cannot produce power for less than 2.24 cents per kw.-hr. when there are 650,000 kw.-hr. generated during the year, there is something wrong both with the installation and in the manner of operation.

When power plants are installed under such conditions and comparisons are made between them, and the question of purchasing power on such a basis, it is not unnatural that the cost of power in the industrial plants should be high, and it is just such plants which make it possible for the central station to get in its service. It is not fair to the industrial-plant owner to get or accept any recommendations when it cannot be shown that the cost of heat, light and power, in the case power is purchased, is less than the cost of heat, light and power when he generates it himself.

Power is not the sole item of consideration. Heat, particularly in the northern latitudes, is of as much importance as power, and it is frequently found that the cost of coal for heating is practically equal to what it would cost for the power, if the heating system is properly laid out, and that, therefore, this item of coal can frequently be eliminated during the heating season and the only charges to be made against the power are the added interest charges for the larger boilers, power-plant installation, oil, waste, etc., with such additional labor as may be necessary to operate the engine plant in addition to the heating plant. During the summer season, all coal must be charged up against power.

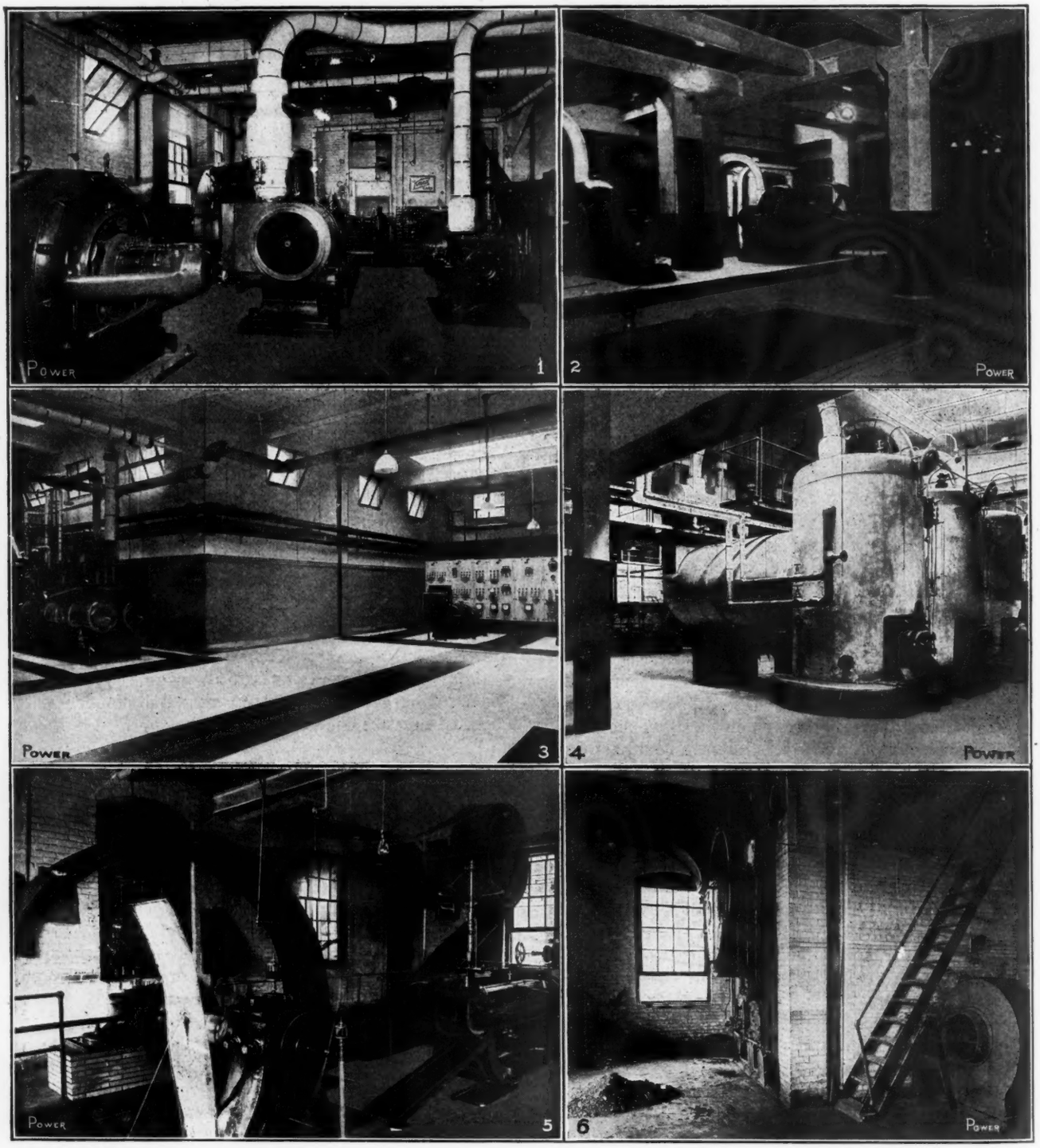
New Rotary Power Pump

A new line of rotary power pumps, in which gear-style cams have been substituted for the three-toed cams, has been placed on the market.

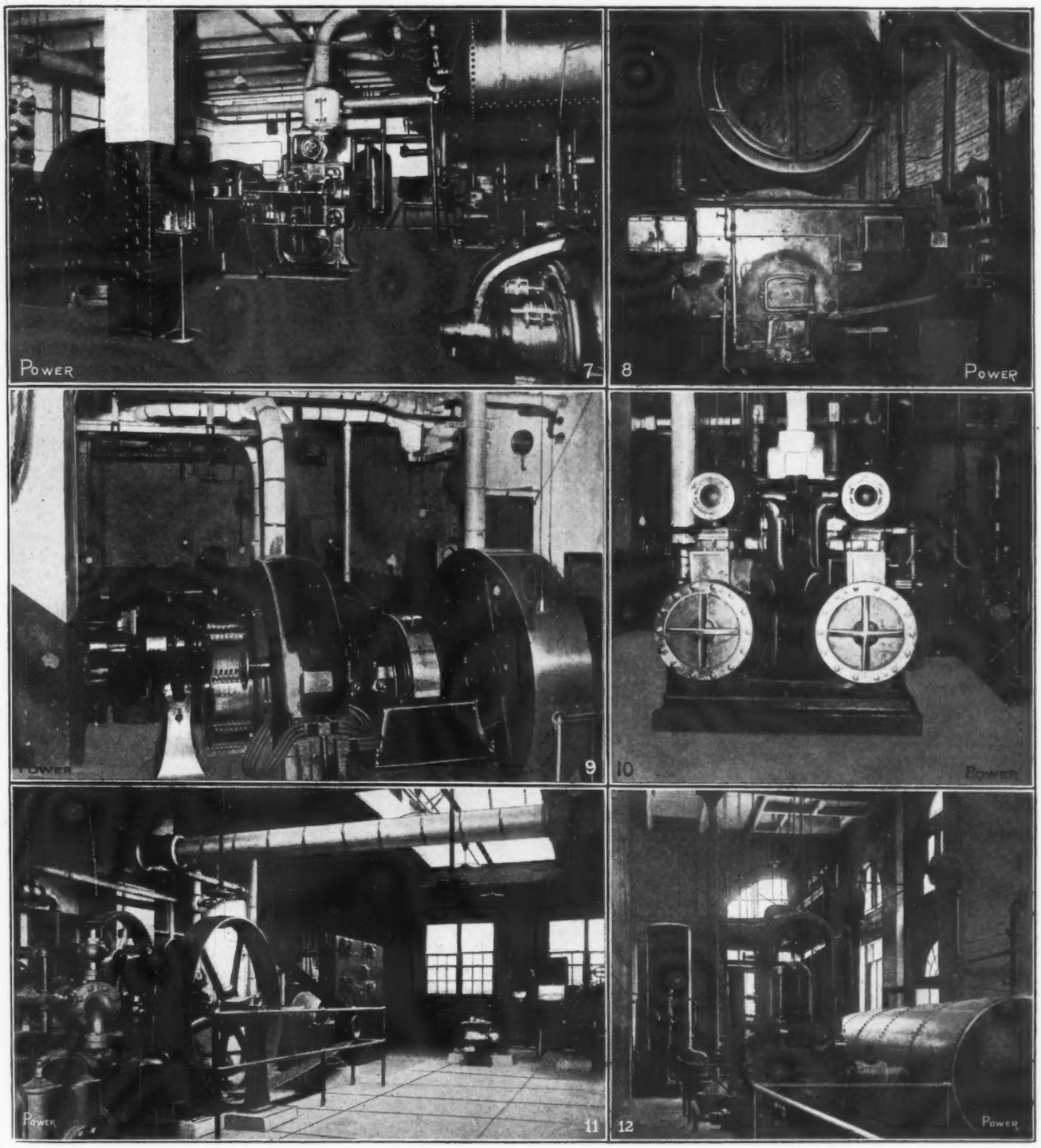
Two sizes are built by the Goulds Manufacturing Co., Seneca Falls, N. Y. One has a capacity of 25 to 50 gal. per min., running at 225 to 450 r.p.m., and the other has a capacity of 50 to 100 gal. per min., running at 225 to 450 r.p.m. Both pumps are suitable for pressure up to 100 lb. or 230-ft. elevation.

They are mounted on a cast-iron bedplate, fitted with an outboard bearing and tight and loose pulleys for belt drive. The suction connection is made within the base directly beneath the case, and is reached through hand holes in the base. The smaller pump has two discharge openings, one tapped for a pipe, the other threaded for a hose coupling. The larger pump has three discharge openings, two fitted as in the small pump, and the third fitted with an interchangeable blank flange.

Oklahoma Coal Output in 1912 Larger Than Ever—The total production of coal in Oklahoma in 1912, according to E. W. Parker, of the United States Geological Survey, was 3,675,418 short tons, having a value at the mines of $7,867,331. These statistics have been compiled in coöperation with the State Geological Survey. The record of 1912 exceeded that of the previous maximum output (in 1907) by nearly 33,000 tons. Compared with 1911, it showed a gain of 19.6%, in quantity, and of 25% in value. The reason for the increased activity in 1912 appears to be the diminution in the supply of natural gas and fuel oil in the markets tributary to Oklahoma coal.



SPRINGFIELD, MASS., WHERE THE NATIONAL CONVENTION OF N. A. S. E. WILL BE HELD NEXT WEEK, IS SOMEWHAT OF A MANUFACTURING CITY. A FEW OF THE POWER PLANTS OF THE FACTORIES, OFFICE BUILDINGS AND DEPARTMENT STORES ARE ILLUSTRATED HEREWITH IN FIGS. 1 TO 12, INCLUSIVE. FIG. 1 IS THE ENGINE ROOM OF THE KNOX CO., MANUFACTURERS OF KNOX AUTOMOBILES. THE LARGE ENGINE DRIVES THE DIRECT-CURRENT GENERATOR SHOWN IN THE FOREGROUND. FIG. 2 IS A PARTIAL VIEW OF THE ENGINE ROOM OF THE MYRICK BUILDING, COMBINED OFFICE AND POWER BLOCK. FIG. 3 SHOWS THE ELEVATOR PUMPS AND ONE OF THE TWO MOTOR-DRIVEN GENERATORS AT THE CENTRAL FIRE STATION. FIG. 4 IS A VIEW OF THE BOILER ROOM OF THE SAME PLANT. THE PUMPS ARE FOR ELEVATOR SERVICE, AND THE GENERATOR SETS SUPPLY CURRENT FOR ILLUMINATING THE ADJACENT BUILDING AND TOWER. ELECTRICAL ENERGY IS PURCHASED AT PRESENT FROM THE CENTRAL STATION, BUT ENGINES AND GENERATORS WILL BE INSTALLED EVENTUALLY. FIGS. 5 AND 6 ILLUSTRATE THE CORLISS ENGINE AND RETURN-TUBULAR BOILER OF THE BARNEY & BERRY CO., MANUFACTURERS OF SKATES.



In Figs. 7 and 8 Is Shown a Partial View of the Engine and Boiler Rooms of the Massachusetts Mutual Life Insurance Building, One of the Finest Buildings in the City. The Engine Room Is Typical of the General Run of Office Buildings, but the Two Boiler Installations Are Interesting, Owing to the Method of Placing the Furnaces, which Are Built below the Horizontal Shell of the Fitzgibbons Boilers. As the Furnaces Are of the Dutch-Oven Type, Equipped with Mechanical Stoker, Quite a Saving of Space Has Been Made. The Engine Room of Forbes & Wallace, One of the Large Department Stores, Is Shown in Figs. 9 and 10. The Generators Are for Lighting Service. the Pumps for Elevator Operation. The U. S. Envelope Co., Envelope Manufacturer, Generates all Electrical Energy Used, in the Engine Room Shown in Fig. 11. The Absorption Refrigerating System, Fig. 12, Is at the Eastern States Refrigeration Co. The Pumps, Boiler, Etc., Are on the Ground Floor and But a Partial View of the Plant Is Shown.

ELECTRICAL DEPARTMENT

Switchboard Signaling in the World's Largest Power Station

In the world's largest power house, the Keokuk generating station of the Mississippi River Power Co., it is more than 800 ft., or nearly one-sixth of a mile, from the switchboard to the most remote generator, and no part of the generator room is visible from the switchboard because the latter is installed in an upper story. For this reason, no efforts were spared to make the signal system as dependable as possible.

Transmitters and receivers are installed on each benchboard, the number corresponding to that of the generator controlled by it, and also one receiver and transmitter are placed beside each generating unit. The left-hand dial of each switchboard set is the transmitter, while the upper dial of the pedestal set is the corresponding receiver at the generator. The lower dial of the pedestal set is the generator attendant's transmitter, while the right-hand dial in the switchboard set is the corresponding receiver.

The transmitter of the switchboard set is operated by means of a handle, pointer, and dial mounted on the front of the benchboard and concentric with the handwheel which operates the field rheostat of the corresponding generator. The pointer of the corresponding receiver in the generator room instantly points to the same signal.

The synchronous motion of the pointers of the transmitter and receiver is secured by means of small induction motors, each provided with a three-phase delta-connected stator winding and a single-phase rotor winding of the shuttle type, the windings being exactly alike in all the machines, and corresponding dials having their signals at exactly the same points with respect to the winding.

Motors for corresponding transmitters and receivers have their stator windings connected in multiple but not excited except by induction from the rotor winding. The rotors are also connected in multiple and are excited from a single-phase source. With two motors connected thus, any motion of the rotor of one is accompanied by a corresponding motion of the rotor of the other. Thus each will always bear the same relative position to its stator winding. In sending signals, the rotor of the transmitter is turned so that the hand pointer on the dial points to the signal it is desired to send and the rotor of the connected machine or machines instantly moves around so that the hand on the dial of the receiver also points to the same signal.

The rotors are excited from a 25-cycle, 125-volt circuit with provisions for automatically throwing them across an auxiliary supply circuit in case of failure of the main supply.

Double push-button switches are located on both sides of the transmission handles, and serve to operate signal lamps, whistles and bells.

To send a signal, the switchboard operator turns the handle to the signal he wishes to send, this action moving the pointer on the dial of the transmitter, and, consequently, the pointer on the dial of the receiver at the generator stand, so that they both point to this signal. He then pushes a button on the right of the transmitting handle, thus lighting a lamp on the generator whose operator is being signaled to and also blowing a whistle to attract his attention. As soon as the operator at the machine has read the signal, he turns the handle of his transmitter to the same signal, thus transmitting the signal he has received back to the switchboard operator as a check. Then he presses the button at the right of his transmitting handle, thus extinguishing the lamp and cutting out the whistle; after which he presses the button at the left of the handle so as to light a lamp in the switchboard room and ring a bell there to attract the attention of the switchboard operator, who, after checking the signal, presses the button at the left of the transmitter handle, extinguishing the lamp and cutting out the bell. This completes the sending and checking of a signal.

The devices for sending and checking signals as outlined above were manufactured by the General Electric Co.

Two Cases of Hunting

We have two 200-kw., 440-volt, alternating-current generators, direct-connected to 12x24x30-in. cross-compound Allis-Chalmers engines, which refuse to run in parallel. These engines are fitted with Harting governors and run at 150 r.p.m. The exciters are belt-driven from the flywheel of the main units and are compound wound. The switchboard is fitted with a synchroscope and the machines go together perfectly, but in the course of 10 to 30 sec. hunting sets in and gradually gets worse. The speed regulation of the units individually appears to be good. Any suggestions as to the probable trouble would be appreciated.

A. N. KERR.

Las Vegas, Nev.

We have one 100-kw., three-phase, 2300-volt, 60-cycle generator, direct-connected to a simple engine of the high-speed Corliss type, and one 75-kw., 2300-volt, three-phase, 60-cycle unit direct-connected to the same type of engine. The 100-kw. machine has 32 poles and runs at 225 r.p.m. The 75-kw. machine has 28 poles, and runs at 257 r.p.m. Both are of the revolving-field type. They will come together all right, but soon hunting sets in, so that one has to be cut out of the line, and the smaller machine will not carry the night load. What can be done to prevent this trouble? The exciters are connected to an equalizing busbar and there is an equalizing rheostat on the switchboard.

V. K. STANLEY.

Ponca City, Okla.

Trouble with Three-Wire Generators in Parallel

In a certain plant, there were two 200-kw., 220-volt, three-wire direct-current engine-driven generators in the original installation, and two 150-kw. turbine-driven units of similar type were installed later, to take care of the increase in the load. The neutral of the three-wire generators was taken from collector rings, as low-frequency alternating current, and the direct-current neutral tap was taken from the middle of the balance coils. All of the machines were compound wound, with the series fields divided so that equal compounding would be developed from each side of the circuit. The two 200-kw. engine-driven generators were eight-pole machines, with four series field coils on each side of the circuit, while the two 150-kw. turbine-driven generators were four-pole machines, having two series field coils on each side.

As long as the load remained fairly steady, the generators operated properly, but as the load changed, an attendant would have to watch the machines very closely, and any sudden fluctuations always resulted in trouble. The two turbine-driven generators would operate in parallel with each other very satisfactorily, but would not operate properly in parallel with the engine units. Numerous changes were made in compounding and in governor adjustments, both on the engine and turbine units, but without much apparent success.

The load recently increased to a point where the turbines had to be operated in parallel with the engines, or be discarded, and as the exact trouble had not been located, a detailed study was made of the conditions before condemning the machines. A careful test was made to make certain that the compounding was correct, using a water barrel to create the load, testing each machine separately, and the machines were left over-compounded 10 volts, as the builders' specifications called for. It was then observed that when the turbine-driven generators were disconnected from the line, after being in parallel with the engine-driven generators, their voltage instantly dropped from the normal voltage of 240 to a point as low as 40 or 50 volts. This was an indication that the series fields had been carrying an undue amount of current, causing the generators to partake largely of the character of series generators and resulting in faulty electrical regulation.

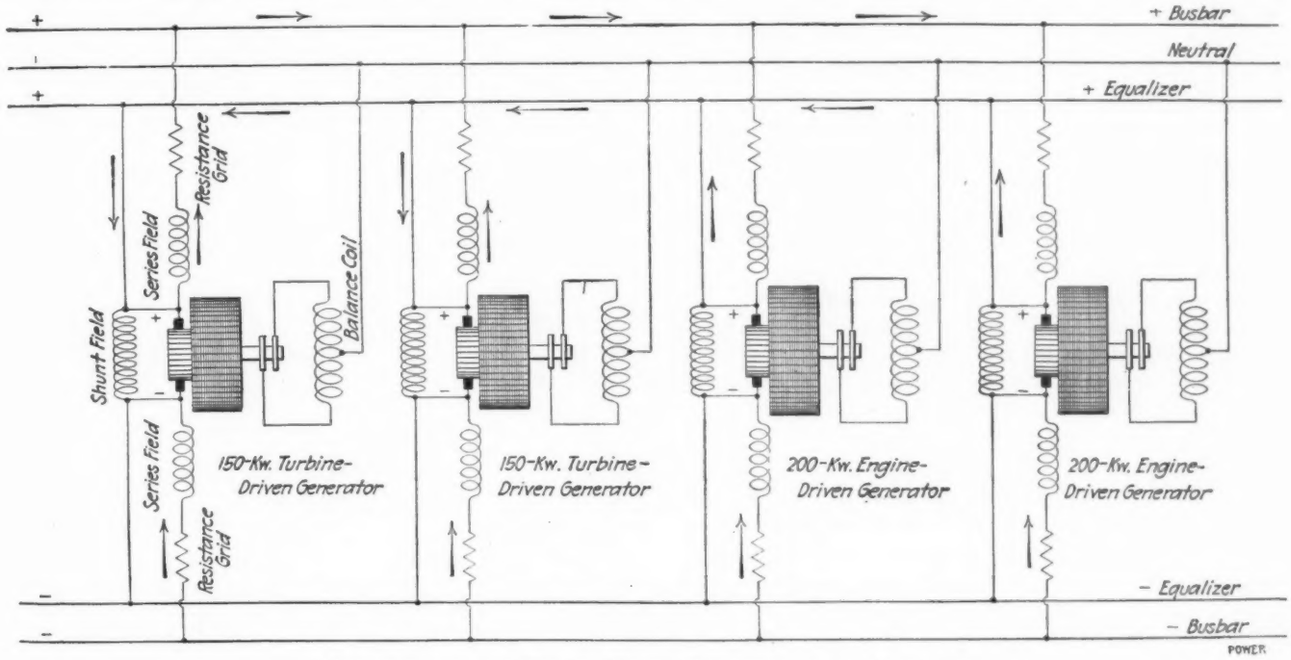
Seeking the cause of this, it was found that on account of the extreme difference in speed, and the number and size of poles, the series field circuits in the turbine-driven generators had only about one-eighth the resistance of those on the engine-driven generators, causing nearly all of the current generated to flow through the positive equalizer and series coils of the turbine-driven generators to the line, as shown by arrows on the sketch, increasing the effect of the series fields enormously.

Ammeters were used to determine the amount of current, and the excess was often nearly 100 per cent. of the normal rating. It was impracticable to reduce the resistance of the series field coils on the engine-driven generators, which would have been a little more efficient, so the resistance of the turbine-driven generator series fields was increased by the use of heavy cast-iron resistance grids, mounted so that they could be added or removed until the proper amount was inserted in the circuit. These grids were so designed that there were no serious losses, and the heating was scarcely noticeable.

When this work was completed the machines operated in parallel without any trouble, and permitted the load to be carried on any combination of generators desired.

H. R. MASON.

St. Louis, Mo.



CONNECTIONS OF THREE-WIRE GENERATORS IN PARALLEL

The electricity supplied in the city of London is in the hands of thirty-one separate enterprises, part of them, including the largest individual outputs being private corporations and the rest municipal enterprises by the various Borough Councils. It is said one can find single-phase systems at 50 and 85 cycles and the three-phase systems at 50 and 25 cycles, and both alternating current and direct current, three-wire systems at all voltages.—Edison Current Topics.

GAS POWER DEPARTMENT

Work at Sulzer Bros. in Switzerland

Three years ago the editor visited Sulzer Bros., at Winterthur, expecting to see the latest and best in steam-engine building. They had not made a large engine there in several years; steam engines are only built at the Ludwigshafen Works. It was all steam turbines and Diesel engines. This year he found that they had abandoned the making of the steam turbine also, and have pinned their faith, so far as power-producing apparatus is concerned, to the Diesel engine. They have brought to its development all the skill and experience in design and workmanship which gave this shop in the Swiss mountains a world's record with its steam engines, and are working out the internal-combustion motor in large sizes scientifically and systematically. They believe it has a large future in the marine field, especially if the number of cylinders can be reduced, and have built purely for experimental purposes a single-acting two-stroke-cycle engine having a cylinder some 40 in. in diameter, 44-in. stroke and running at 165 r.p.m., with which they have developed between 1600 and 1700 hp. in a single cylinder, and out of which they hope eventually to get 2000 hp. If this can be done the powering of even a large and fast steamer will be quite practicable, considering that the boilers and condensers are done away with and less space would be required for the fuel.

They have perfected a reversing gear with which the engine is handled as positively and easily as a steam engine, and the valve gear, outside of the starting mechanism, is reduced to the fuel valve and auxiliary scavenging ports above the exhaust slots in the cylinder, closing them during the expansion stroke but holding them open during the return stroke and lengthening the period for scavenging and exhaust. The engine is tied together by four massive rods between the top cylinder head and the bed, relieving the cast-iron cylinder and guides from the longitudinal working stress. The maximum pressure upon the piston is some 300 metric tons.

One of the successful boats fitted with Sulzer-Diesel engines is the "Monte Penedo," of the Hamburg-South American Line, which has made a successful voyage from Hamburg to Buenos Ayres and back and has lately arrived in New York from another South American port. She is a 6000-ton freighter and makes about 10 knots with two 2-cycle single-acting engines of 850 hp. each.

We saw upon the floor two Diesel engines for United States torpedo boats. It was somewhat surprising to see, way up there in the mountains, miles from any water which it would navigate, a 200-ft. steamer on the ways. These boats are built in considerable numbers, fitted with engines and boilers and everything but the woodwork and sent to the Swiss lakes. The one which we saw was a side-wheeler with 1000 hp. and was going to Lake Geneva.

All this does not mean that the bulk of their power work is marine. They have built and are building many good-sized Diesel engines for stationary work, a recent delivery being a 6-cylinder engine to drive a 2500-kw. alternator for the A. E. G.

We have referred before to the excellence of their boiler work. An extra bending roll is used to avoid the tangential edge left by the three-roll process. The bent sheet is then stood endwise upon a face-plate, the edges are planed vertically and brought together, the butt straps bolted on, perfect circularity assured, and then all the holes are drilled through the butt straps and the sheets, no punching being used anywhere in the process. We saw a boiler shell 8.5 ft. in diameter and 9.5 ft. long made of a single sheet.

Centrifugal pumps is another of their products, and they are handling heads of 2000 ft. with eight stages.

One department of the works is devoted to heating boilers, radiators and heating apparatus, which they manufacture in great quantities. They have a number of installations in which the exhaust of Diesel engines is used for heating purposes.

⁂

New Method of Cooling Gas Engines

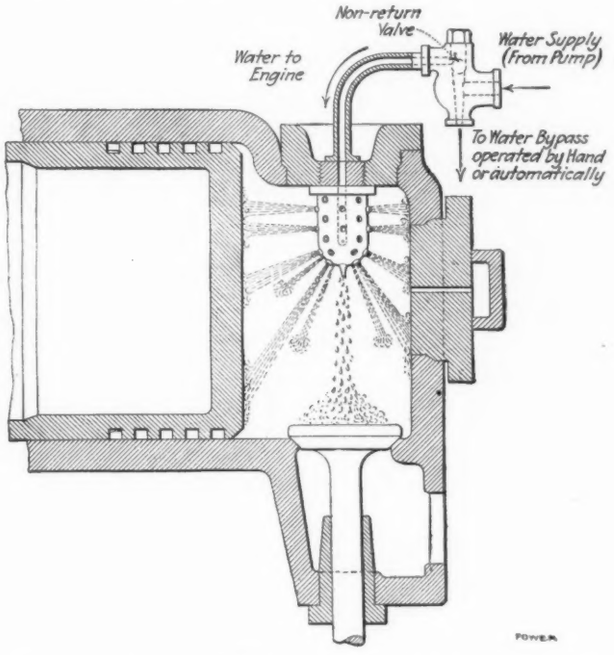
In a paper read before the Institution of Mechanical Engineers, at Cambridge, on July 29, Prof. Bertram Hopkinson, who, for many years, has been engaged in research in connection with gas-power plants, described a new method of cooling the cylinders and pistons of gas engines.

Ordinarily about 30 per cent. of the heat value of the fuel passes from the hot gases to the cylinder walls and pistons. In order to prevent the overheating of these parts under test conditions, it is necessary to provide a water jacket around the cylinder, and, in the case of large engines, to circulate water through the pistons and around the exhaust valves. Most of the disadvantages under which the gas engines labor are due directly or indirectly to this fact. The complicated and thick-walled castings required for the cylinders are apt to crack under the influence of the wide variations of temperature, and overheating of deposits on the internal walls of the combustion chamber causes pre-ignition, so that it is not always practicable to work a gas engine continuously at its maximum output.

The idea of introducing water into an internal-combustion engine is not new. It is a common practice in oil engines to introduce water along with the oil in order to permit the compression to be raised, and water has been injected into gas engines for the purpose of preventing preignition. Proposals have also been made to introduce water for the purpose of cooling parts of the metal. None of the latter, however, have been practical, if indeed they have ever been more than just proposals on paper, apparently because their originators did not appreciate the conditions which must be satisfied with the injected water to act as an effective cooling agent. If the water be turned into steam before reaching the metal it will not exert any cooling effect, except indirectly by

lowering the temperature of the flame, and such lowered temperature is accompanied by a considerable loss of efficiency. On the other hand, water which reaches the walls in liquid form and is there evaporated, absorbs out of the heat given to the walls by the gas the whole of its own heat of evaporation, and there is no loss of thermodynamic efficiency, because the heat used is waste heat, which, in a jacketed engine, would go to warm the cooling water.

The author claims that it is of no use to inject the water in a fine spray, or to introduce it into the gas or air pipe, so that it is carried in suspension in the incoming charge, or, as is often done in oil engines, to spray it in along with the oil. Although some of these devices have proved useful for the prevention of pre-ignition and for the softening of the explosion, none are effective for the purpose of cooling.



SECTION THROUGH HEAD OF CYLINDER, SHOWING WATER JETS

The author found, however, that by injecting water in comparatively coarse jets against the internal surface of the cylinder, and the head of the piston, the metal can be kept cool without materially cooling the gases, with the result that there is no loss of efficiency. The temperature of the parts can be perfectly controlled, and simple single-walled castings can be used for the cylinders.

Experiments of Dugald Clerk, the author, and others have shown that the rate of heat-flow from the gas into the metal is far more rapid at and soon after the instant of ignition than at any other time. It seems likely from these experiments that for practical purposes the heat flow into the barrel of the cylinder during the last three-fourths of the expansion stroke might be so small compared with that in the first period that direct cooling of this portion of the cylinder could be dispensed with altogether. This anticipation has been found correct, and it has been found necessary only to direct the spray against the walls in the combustion chamber, and the piston, the rest of the cylinder being kept cool by conduction. Cold water is injected through a hollow casting projecting into the combustion chamber and provided with a number of nozzles or holes about $\frac{1}{32}$ in. in diameter, from which the jets are projected against the metal surfaces.

For the purpose of experiment, an 11½x21-in. Crossley engine, rated at 40 hp., was fitted with a new cylinder consisting of a plain barrel without a water jacket. A section of the cylinder is herewith shown. The injection rose is a hollow casting projecting into the combustion chamber and provided with 25 holes, as shown. The drip from the rose suffices to cool the exhaust valve. A simple plunger pump driven by a cam injects a charge of water once in a cycle, lasting from about 30 deg. before to 30 deg. after the point of ignition, during which period practically the whole of the sliding surface of the barrel is covered by the piston. The quantity of water used was about 2.4 lb. per brake horsepower-hour, and the temperature of the engine ranged from 150 to 180 deg., C. The engine consumed about 15 cu.ft. of coal gas per brake horsepower-hour, both when it was water-jacketed and after being fitted with the new cylinder.

Tests at other loads showed that with a weak mixture the gas consumption is slightly increased by the water injection, but with very rich mixtures it is a trifle less. The difference, however, does not exceed 5 per cent. either way, and on the average it may be said that the economy is unaffected by the use of this method of cooling.

This engine was set to work driving a dynamo, and its speed was increased from 180 to 195 r.p.m., when it was found capable of developing 50 b.hp. for many hours, an increase of 25 per cent. on its original maximum safe load. It has now been running for a total period of 5000 hr. on regular work, giving no trouble at all, and the combined wear on both cylinder and piston is less than 0.01 in.

To regulate the water supply in accordance with the load the pump is connected to the governor, which is of the hit-and-miss type, so that the pump only takes a stroke when the engine takes gas.

With a throttle governor a corresponding regulation is easily provided. A simple thermostat has also been devised, which automatically controls the supply of water during starting and when the engine is running, quite satisfactorily.

In case of failure of the water supply, nothing happens except that the engine slowly heats up, and after ten minutes or so, preignitions occur, bringing the engine to a standstill. No damage results from this, but to guard against any possible danger a fusible safety plug is screwed into the combustion chamber, which melts if the cylinder gets too hot, and the noise of the escaping gases warns the attendant.

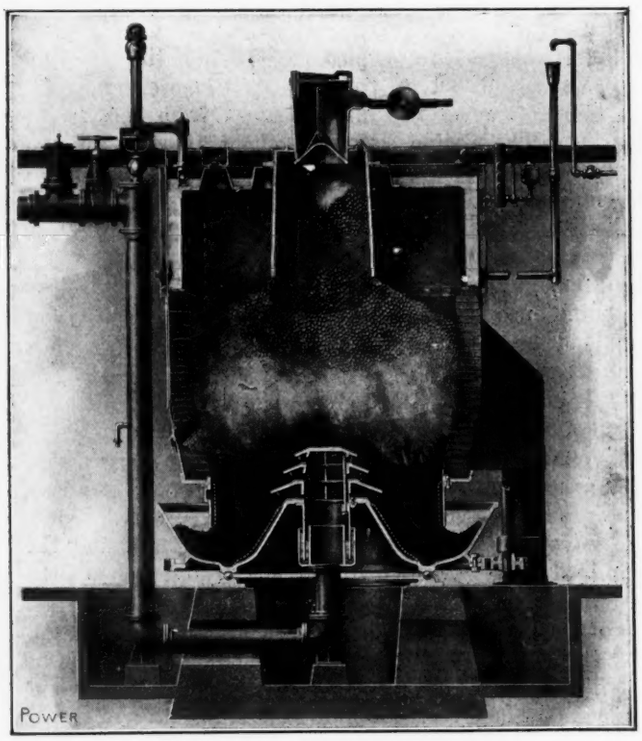
The system has also been applied to an engine of 105 hp., and to one of 1000 hp.; in each case the original cylinder was used, without water in the jacket. The large engine was run under load 30 hr. without a stop; after a short stop for adjustments, it ran for 70 hr. without a stop, driving a factory, and developing an average of 800 hp. The whole of the injection apparatus for the 1000-hp. engine cost only $100, and within a few hours of putting it on the engine it was doing all the work of the cooling tower, centrifugal

pumps, etc., previously used. An 18x24-in. two-stroke-cycle single-acting engine has been built for use with the new system, and is now undergoing trials.

New Gas Producer

In the May 27 issue we described at some length the Illmer two-stroke-cycle gas engine—a product of the Reading Iron Co. More recently, however, this company has taken up the producer end of the problem and has developed a producer for use with either anthracite or bituminous coals.

As shown in the illustration, this producer while representing nothing radically new, nevertheless, combines a number of the well recognized points of good design.



SECTION THROUGH READING PRODUCER

Perhaps the most important feature is the agitation of the fuel bed by a rotating water-sealed ash tray, thus tending to eliminate blow holes by a twisting action through the hottest part of the combustion zone, and at the same time continually removing the ashes.

A uniform blast distribution is attained by having the blast tuyeres consist of three separate hoods which rotate with the ash tray. The passages from the central-blast pipe to the hood chambers are contracted so as to maintain the same blast pressure to each chamber. The vaporizer forms the upper part of the producer and the blast saturation is automatically controlled by a thermostat in the blast pipe.

A rachet drive actuates the ash tray at a slow speed—several revolutions per hour; and the tray is so designed as to permit any of its parts being replaced without disturbing the stationary shell.

For bituminous coal installations a cooling tower and mechanically operated gas scrubber are furnished. This scrubber is of the centrifugal type and carries a two-stage rotor consisting of a pair of spaced disks provided with radial blades on both sides of each disk. The casing is divided into two communicating compartments, each of which encloses one of the bladed disks, thus forming two independent stages for the tar extraction. A set of nozzles at each stage directs the water spray toward the rotor blades.

Splash Lubrication

In the July 29 number Mr. Westwood tells how he cut down the oil bill on a vertical gas engine $300 per year by lowering the oil level in the crankcase and adding a pump to his splash-feed system.

Now, it seems to me that the great beauty of the splash-oiling system is its simplicity and reliability. Therefore, if possible, it should be adjusted to distribute the oil properly without recourse to such complications as pumps, piping and feed cups. Instead of lowering the oil level in the crankcase I like to raise the level until the bearings have copious streams of oil pouring through them. Then I cut down the amount of oil that splashes up into the cylinder by baffles made of sheet metal. One may usually be placed across the lower end of the cylinder with a slit across it for the connecting rod to work in. This slit should not be made too small as the air below the piston has to flow back and forth between the cylinder and crankcase at every revolution of the engine. If this baffle is not enough, others may often be placed on the connecting rod, traveling up and down with it, sometimes below and sometimes above the stationary baffle. In one place, where I could not place baffles at any of these points, I fastened one to the piston, hanging it several inches below the lower end of the piston, with a slit in it for the connecting rod.

I probably am something of a crank when it comes to splash lubrication, as I have even used it on a horizontal engine. It worked very well, but there were so many baffles that an agent of the makers thought someone had been putting junk in the engine for the purpose of wrecking it. This engine ran "over"; I have never tried it on an engine running "under."

FRED BOONE.

Davidson, Okla.

Peat Production Small

While the United States is the richest country in the world in the deposits of peat, little active work is done in mining or digging it. So far as is known very few of the peat-fuel plants established have gone beyond the experimental stage and many of them have never been equipped with essential machinery.

Reports from all known peat-fuel plants in the United States, according to an advance chapter from "Mineral Resources, 1912," on the production of peat in 1912, by Charles A. Davis, show that with one exception they were idle during the summer of 1912.

The output of peat fuel was reported as about 1300 tons, valued at $4550. All this peat was sold. A copy of the report on peat may be obtained free on application to the Director, U. S. Geological Survey, Washington, D. C.

REFRIGERATION DEPARTMENT

Ammonia Condensers

By Fred Ophuls

Several new types of open-air ammonia condensers have recently been put on the market with certain claims of superiority, and it appears not untimely to say a few words on this subject. There are four distinct classes of ammonia condensers and these again may be subdivided into several types, each varying in their general arrangement and in the relative directions of flow of the cooling water and ammonia.

Before studying the effect of the design and construction on the efficiency of operation during each of these separate periods a brief description of the various types will be given. Only those types and designs most commonly used will be considered.

Condensers Classified

Ammonia condensers may be classified as follows:

Open-air or atmospheric condensers—Flow of water perpendicular to the flow of ammonia. (a) The water and ammonia flowing in the same general direction. (b) The water and ammonia flowing in general in opposite directions, commonly called counter-current type. (c) A combination of types (a) and (b).

Double-pipe condensers—Flow of water parallel to flow of ammonia. (a) Counter-current type. (b) A combination of counter-current flow and flow in the same direction.

Surface condensers—(a) Spiral-coil types. Flow of water perpendicular to flow of ammonia. (b) Straight-tube types. Flow of water parallel to flow of ammonia either counter-current or a combination of counter-current flow and flow in the same direction.

Submerged condensers—(a) Spiral-coil types. Flow

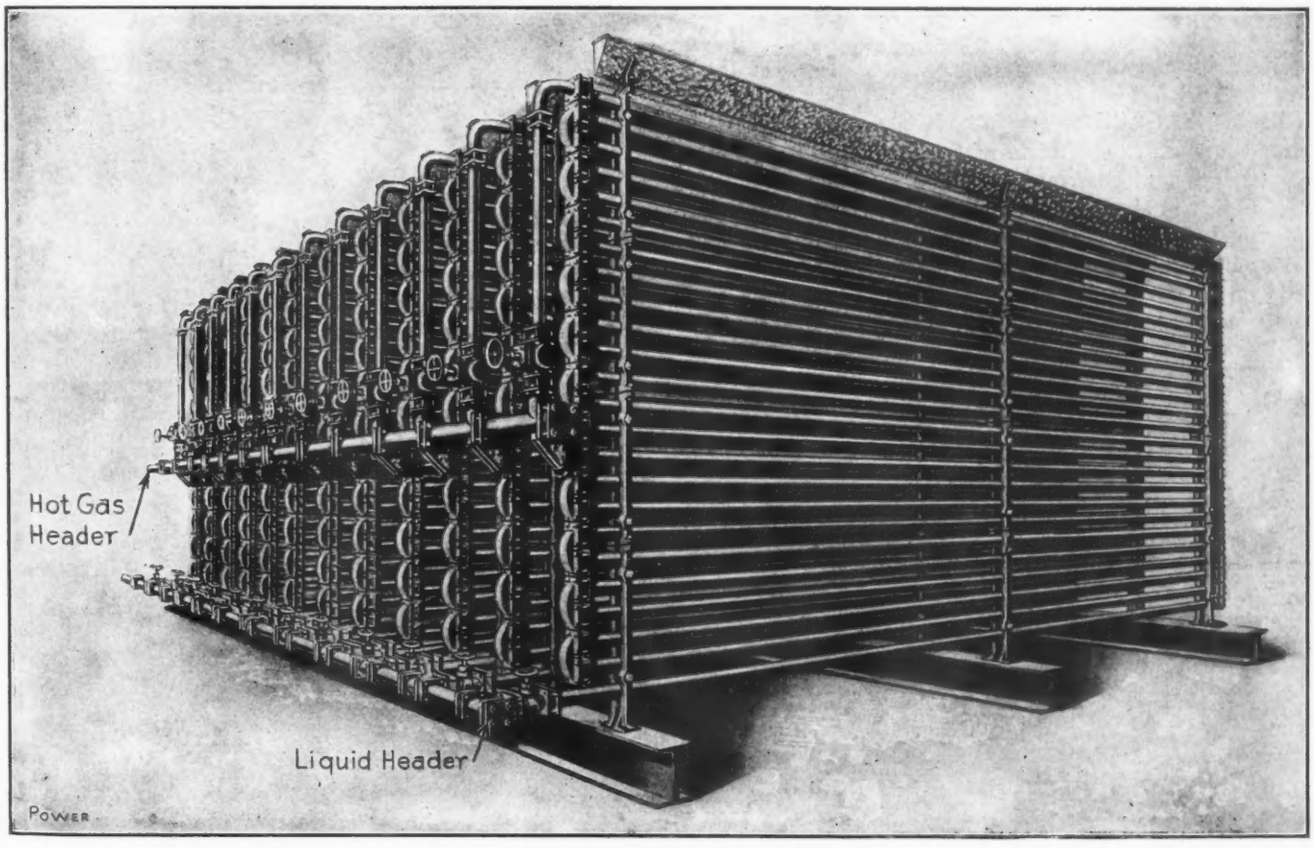


Fig. 1. A Large Type (a) Atmospheric Condenser

The function of an ammonia condenser is to cool and liquefy at the lowest economical pressure the compressed ammonia vapors discharged into it. The work done in the condenser can be divided into the following distinct periods:

1. Superheat period, during which the sensible heat of the vapor is removed, that is, the temperature of the superheated vapor is reduced to the temperature of liquefaction.
2. Liquefaction period, during which the latent heat is removed, that is, the vapor is liquefied.
3. Liquid forecooling period, during which some sensible heat is removed from the liquid, that is, the liquid is cooled below the temperature at which it is liquefied.

of water perpendicular or parallel to flow of ammonia. (b) Straight-coil type. A combination of parallel and perpendicular flow.

Figures 1 to 14, inclusive, are illustrations of the most common designs of these various types. In this issue only atmospheric condensers will be considered, but the other three classes will follow in a later issue.

Open-Air or Atmospheric Condensers

Type (a) condenser, illustrated in Figs. 1 and 2, consists of one or more vertical stands of pipe coils, each made up of either 24 or 18 two-in. 20-ft. lengths of pipe placed horizontally and joined into one continuous coil by means of return bends. The ammonia in the form of vapor enters each coil at the free end of the top pipe and leaves condensed into a liquid at the free end of the bottom pipe. This construction requires that the hot ammonia vapor comes in contact with the cooling water at its lowest temperature and the liquid ammonia leaves at the point where the water has attained its maximum temperature. These conditions of operation do not produce the lowest liquefying pressure and lowest final temperature of the liquid.

Due to this condition efforts have been made to design an open-air condenser making use of, at least to some extent, the counter-current principle.

In Fig. 3 is shown a counter-current condenser (type (b), which fulfills most of the requirements of economic operation. This condenser is of the same general construction as the condensers above described, but the hot ammonia vapor enters at the free end of the bottom pipe

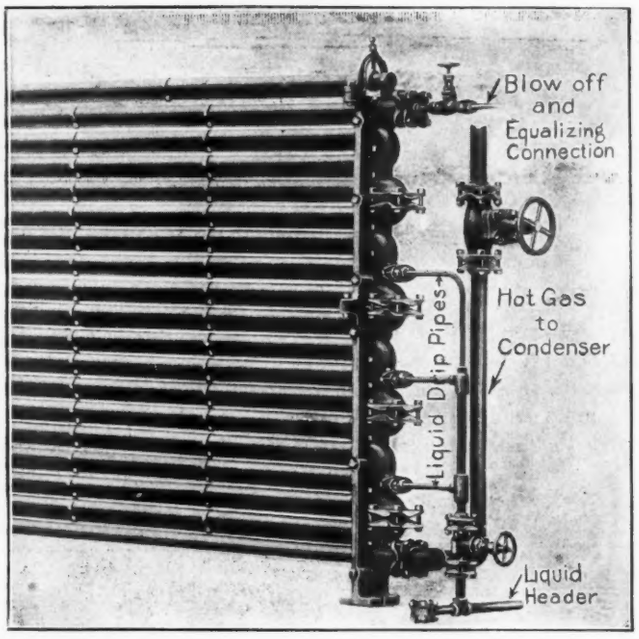


Fig. 3. An Atmospheric Condenser of Counter-Current Type

and by means of liquid drip pipes, attached at the fourth, eighth, twelfth and sixteenth pipes from the bottom, for the coils 24 pipes high, and at the fourth, eighth and twelfth pipes for the coils 18 pipes high, the liquid is drained off practically as soon as it forms, so that most

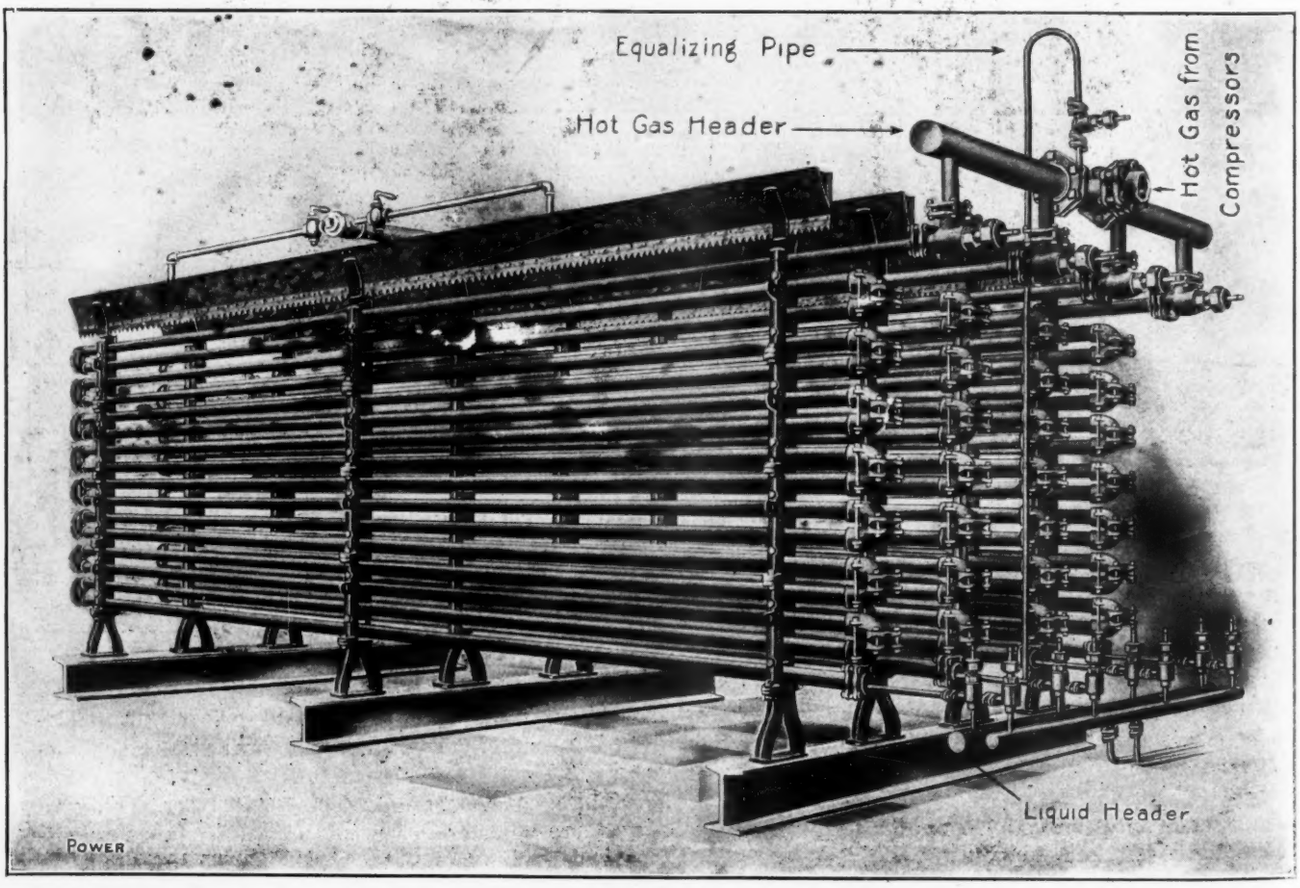


Fig. 2. Another Atmospheric Condenser of the Same General Type as Fig. 1

of the pipe surface is available for liquefying purposes. This arrangement of the ammonia and water currents brings the condensing water at its initial temperature in contact with the liquefying vapor and the hottest water with the cooling vapor.

Fig. 4 illustrates another type of counter-current open-air ammonia condenser, in which the ammonia vapor enters the free end of the bottom pipe and the liquid ammonia leaves at the free end of the top pipe. This type was recently designed and constructed by Louis

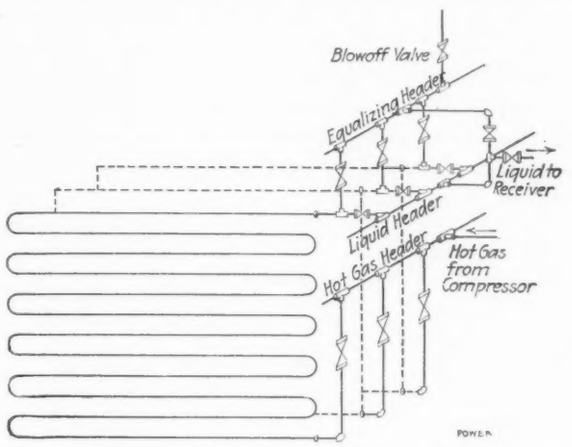


FIG. 4. OPEN-AIR AMMONIA CONDENSER, BLOCK SYSTEM

Block, consulting engineer. In these condensers all the liquid ammonia condensed must be forced upward by the current of the ammonia vapor so that it can be discharged from the top pipe. This requirement is entirely opposite to the principle adopted for the design embodied in the condenser shown in Fig. 3.

Type (c) condenser, a combination of types (a) and (b), was constructed with the idea to offset, at least to some extent, the disadvantages of type (a). From Figs. 5 and 6 it will be seen that the hot ammonia vapor enters at the free end of the bottom pipe and flows up through the lower two or three pipes respectively, and is then brought by means of a vertical riser into the top pipe. The purpose of this construction is to remove the vapor superheat in the lower pipes and liquefy the vapor as it flows down through the upper pipes, the liquid finally leaving at the ends of the third or fifth pipes from the bottom, respectively. The purpose of the ejector *A*, shown in Fig. 6, will be explained hereafter.

Ammonia in Brine

In POWER of July 8 there was a short article on the effect of ammonia in calcium-chloride brine when used in a refrigerating system. My experience with brines of all classes leads me to feel that while the general trend of this article is correct it may be somewhat misleading, for the reason that there are on the American market several chlorides which in name are called calcium chlorides, whereas in fact they are mixtures, mechanical or otherwise, of at least two and generally three chlorides, namely, calcium chloride, magnesium chloride and sodium chloride, in varying proportions according to the brine from which they are crystallized. The action of ammonia on a straight calcium-chloride product is not the same as on one of these mixed-chloride products when they are dissolved in water to make brine.

Calcium chloride is not precipitated from brine by the addition of ammonia, whereas magnesium chloride is

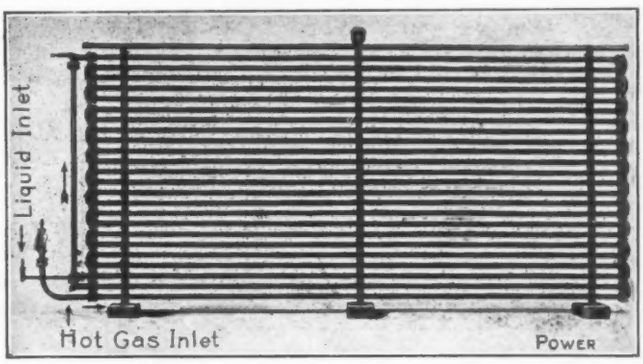


FIG. 5. ATMOSPHERIC CONDENSER, TYPE (C)

precipitated in amounts varying with the conditions attendant. Under ordinary conditions sodium chloride is not precipitated by the addition of ammonia. In this matter we are chiefly concerned with the relative behavior of calcium chloride and of magnesium chloride toward ammonia, either gaseous or in solution in water.

In the article, of which this is a discussion, the statement is made that when ammonia gets into a calcium-chloride brine that, unless the ammonia content becomes sufficiently high to keep down the amount of calcium chloride which will dissolve in the given amount of water, there will be no bad effects, in fact the freezing point of the brine will be somewhat lowered.

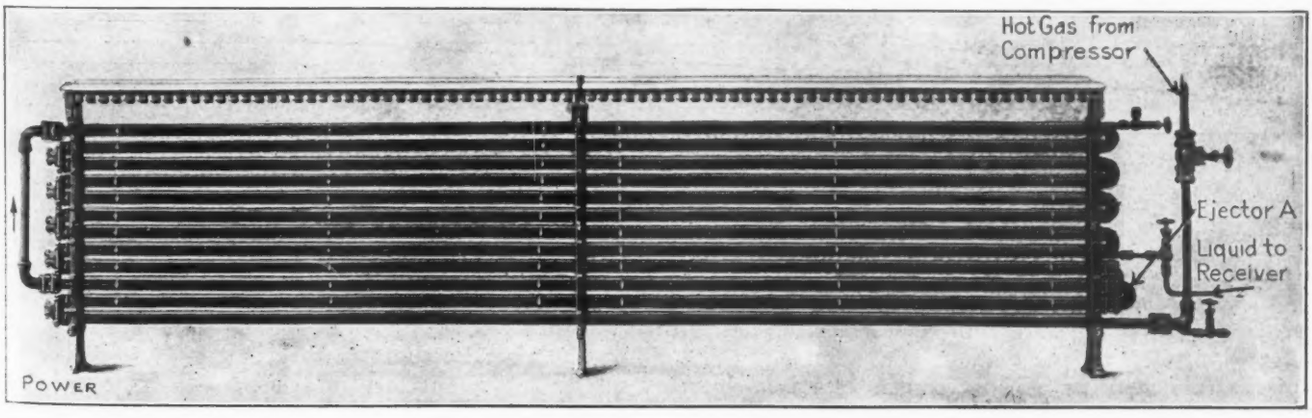


FIG. 6. ANOTHER DESIGN OF TYPE (C) CONDENSER

In the case of mixed-chloride brines, according to my experience, ammonia at once precipitates out of solution the magnesium chloride which in this reaction is converted to magnesium hydroxide. The result of this action is the reverse of that noted above in the case of a straight calcium-chloride brine, for with the loss of magnesium chloride from the brine the freezing point actually rises. When this occurs a sludge is formed in the brine, in amount proportional to the amount of ammonia which has entered into the brine. If this sludge is of sufficient amount, with the corresponding rise in freezing point, as has been the case in several instances of which the writer is cognizant, it has happened that the whole circulating system for the brine has become clogged and in at least one case pump heads have been forced off on this account. Needless to say, there is also the danger of a heavy sludge forming in the bottom of the brine tanks, an occurrence likely to cause much difficulty in the operation of the plant.

For a more definite treatment of this subject the writer would refer the reader to an article, written by the writer, appearing in *Ice & Refrigeration,* Vol. 42, No. 2, p. 91, February, 1912, which gives quantitatively the results of passing ammonia gas into brines of the following description: Each brine was of a strength equivalent to 1.2 sp.gr. at 23 deg. C. Distilled water was used in each case to dissolve the chlorides.

1. Brine made up with chemically pure calcium chloride.

2. Brine made up with chemically pure magnesium chloride.

3. Brine made up with a commercial straight calcium chloride containing no magnesium chloride, but with something like 1.5 per cent. sodium chloride.

4. Brine made up with a commercial mixed-chloride product containing the three chlorides, calcium, magnesium and sodium, the original chloride containing 53.90 per cent. calcium chloride, 12.12 per cent. magnesium chloride and 0.43 per cent. sodium chloride, the remainder being water of crystallization.

When ammonia was passed into these brines no precipitation took place in the case of brines 1 and 3, whereas in the case of brines 2 and 4 immediate precipitation took place. Under certain conditions fully 97.5 per cent. of the total magnesium chloride in brines 2 and 4 was precipitated out of the solution in the form of a heavy, white sludge.

Considering the character of the brines used in these tests, there can be no question with regard to the different behavior of ammonia toward them, the brines affected by the addition of ammonia being in each case those which contain magnesium chloride. As noted above, ammonia does not, except in the presence of carbon dioxide gas in excess, precipitate sodium chloride from solution.

MORGAN B. SMITH.

Detroit, Mich.

Log Sheet for Ice Plant

The writer offers herewith a daily log sheet that will provide a detailed statement of the practical operation of a compression can-ice-making plant. Keeping such a record stimulates the engineer to his best efforts and the list of daily records soon becomes a valuable reference by which past and present operation may be compared. The records also furnish the management with the details of operation and the conditions existing in the plant. More confidence will be placed in the engineer who furnishes such reports. For his own benefit as well as the general welfare of the plant, every engineer, no matter how small the plant, should keep some record of the daily operation.

New York City. M. J. ELLSWORTH.

DAILY OPERATING SHEET ---------- 191

HIGHEST TEMPERATURE OBSERVED ---------- WEATHER CONDITIONS

STEAM BOILERS				REFRIGERATING MACHINES				STEAM CONDENSERS				WATER TEMPERATURES	
No.	Started	Stopped	Hr. Run	No.	Started	Stopped	At R.P.M.	No.	Started	Stopped	Hr. Run	Boiler Feed	
1				1				1				Storage Tank	
2				2				2				Filler Water	
3				3				3				Cooler Water	
4				4				4				River Water	
5					Total Machine Tons				Total Condenser Hr.			Condensing Water	
6					Condenser Pressure				Condenser Vacuum			Condenser Discharge	
	Total Boilers Hours				Back Pressure				Exhaust Line			Liquid Ammonia Line	

No.	River Pumps		Hr. Run	No.	Evaporators		Hr. Run	No.	Generating Units		Hr. Run	METER READINGS	
1				1				1				City Water	
2				2				2				Boiler Feed	
3				3				3				Lighting	
	Total Pump Hours				Total Evaporator Hr.				Total Machine Kw-hr.			Power	

ICE TANK TEMPERATURE AND TIME RECORDS

No. of Tank	Time 6 A.M. to 6 P.M.												Amount of Ice	
	6	7	8	9	10	11	12	1	2	3	4	5	Pulled	In Tank
	Temperatures													
1														
2														
3														
4														
12														
13														
14														

No. of Tank	Time 6 P.M. to 6 A.M												Amount of Ice	
	6	7	8	9	10	11	12	1	2	3	4	5	Pulled	In Tank
	Temperatures													
1														
2														
3														
4														
12														
13														
14														

NO. ROW STARTED	NO. ROW FINISHED			NO. ROW STARTED	NO. ROW FINISHED
Cleaning Boilers	NO.	Water Filters Washed	NO.	General Remarks	
Cleaning Economizer		Water Coolers Washed			
Cleaning Condensers		Filler Lines Washed			
Cleaning Evaporators		Discharge Lines Washed			
Cleaning Cake Filters		Deoderizers Washed			

Chief Engineer

POWER

EDITORIALS

Progress in Gas-Engine Design

The new method of cooling gas engines, devised by Professor Hopkinson and described elsewhere in this issue, deserves close attention in view of the important bearing it may have upon the future of the gas engine. The success which has been attained with this system, on an engine of one thousand horsepower, which was not even specially designed to suit the new conditions, indicates that the costly castings hitherto required for the cylinder, as well as the elaborate provision for cooling and circulating the cooling water, might as well be dispensed with; a simple single-walled cylinder will suffice, and the piston will require no internal circulating water. Moreover, the speed and output of the engine may be materially increased. All these factors combined would apparently reduce the cost per horsepower by perhaps twenty-five or thirty per cent., thus at once bringing the gas plant into keen competition with the steam plant as far as first cost is concerned.

The system can hardly be regarded as in the experimental stage, since a forty-horsepower engine fitted with Professor Hopkinson's cooling device has already run for five thousand hours under ordinary load conditions, and was found to be in no way adversely affected by the application of the cooling water to the interior of the cylinder.

The gas plant, when working under favorable conditions, can already show remarkable results in running costs. The increased reliability conferred upon it by the new method, which practically eliminates the risk of cracked cylinder heads and wreckage of the engine due to a failure of the cooling-water supply, will remove one of the most weighty objections to its adoption.

It should be observed that this new development is not a chance discovery, but the fruit of prolonged investigation and research on scientific lines. Professor Hopkinson is a son of Dr. John Hopkinson, whose splendid work in laying the foundations of scientific dynamo design insured him a place in technical history.

❋

Negligence of Elevator Operators

Engineers of experience in office buildings having hydraulic elevators know of the many troubles occasioned by the carelessness of operators. In large buildings the situation is aggravated by the operators usually being under the direction of the janitor. The chief engineer having no authority over them cannot properly discipline them when they are guilty of carelessness. The janitor, knowing little or nothing about machinery, cannot appreciate to what extent his operators' carelessness causes damage and makes unnecessary work for the engineering department.

A favorite trick with many operators is to depend upon the automatic to stop the car at the top floor instead of using the control lever. Usually it works, but there are times when it does not, and then there is a collision with the overhead works and more or less serious damage is done.

It is useless for any of the engineering force to attempt to catch operators depending solely on the automatics by riding with them to the top floors. They do right when watched. But the negligent ones may easily be detected by observing the pilot valves and the governor cables at the bottom of the shaft.

One company owning a group of office buildings having a total of about forty elevators has created an elevator department separate from the engineering department. The head of this department is responsible for the operations of cars, repairs of all elevator machinery except the pumps, and has charge over all the operators. In a card system, each operator has a card on which is recorded the date and nature of every accident to the car he was operating at the time and whether or not he was responsible for the accident. Careful operators whose habits are commendable receive more pay than those who are less attentive to their duties.

The results of the new system are indeed gratifying. There is no more friction between the janitor and the chief engineer or elevator foreman, and overhead collisions because of failure to stop with the operating lever are very rare.

Similar systems might be adopted in other office buildings, hotels, department stores, etc., with good results.

❋

Cincinnati Smoke Rules

After considerable study and investigation, the Boiler, Furnace and Stack Code Commission of Cincinnati has handed in its report, as told on page 349 of this issue.

Like many of the Middle Western cities, Cincinnati is troubled with the emission of objectionable smoke from the furnaces of steam boilers, stationary, locomotive and marine. Unlike many cities, Cincinnati has appreciated that smoke abatement is an engineering problem. Engineers are doing the work that requires engineering talent instead of leaving it to a health, building, or some other incompetent department.

The proposed rules (perhaps adopted by the Council since we went to press) give the Smoke Inspection Department authority to supervise the construction of all boiler furnaces and require alterations to furnaces not in operation if such are necessary. The smoke-density indicator is good when used correctly and equitably, a thing not done by most authorities responsible for the enforcement of city smoke ordinances.

We would recommend to such authorities and to the Smoke Inspection Department of Cincinnati, the manner of determining when a stack becomes a nuisance, that is followed by the Smoke Inspection Department of Chicago:

Instead of holding as a nuisance a stack which emits smoke of No. 3 or 4 Ringelmann chart for a stated time,

establish a "smoke unit" system (see POWER, page 202, Aug. 6, 1912). Otherwise owners of a chimney emitting smoke of say, No. 2 Ringelmann density for ten hours, thus producing a great amount of smoke, will not be within the law, while owners of stacks emitting smoke of No. 3 density for a short time only could be prosecuted. Most any central-station plant will produce objectionable smoke for short periods when quickly disturbing the banked fires to meet the suddenly great load fluctuations due to summer showers, etc.

In the smoke-abatement movement that is becoming so widespread there is one fact that engineers should emphasize. That is, that when burning many if not all grades of bituminous coal under usual operating conditions, it is impossible to obtain actual smokeless combustion. It should be made clear that with care and proper furnaces, combustion of such coal will produce smoke, but of a density and volume that is not objectionable.

Citizens, ignorant of the problems of smoke abatement, believe statements by some engineers or *pseudo* engineers that "absolutely smokeless combustion is possible," and the most unreasonable demands are made of the smoke-inspection authorities and owners of boiler furnaces.

❋

Boiler Tube Failures

A recent tube failure in an almost new water-tube boiler serves as a reminder that such accidents are a source of constant danger. A recognized authority recently stated that the loss of life and limb exacted by tube failure in water-tube boilers probably exceeds that due to any other class of boiler accident.

The particular failure here mentioned resulted in the death of one man and the serious injury of another. The boiler, of the box-header type, was one of three in a modern office-building plant and had been in service less than 18 months. Two boilers were in service at the time of the accident, which occurred at 3 o'clock in the afternoon, while the third was out for cleaning. The boilers are equipped with chain-grate stokers and the boiler room is arranged with two floors, one at the usual level, a few feet below the grate level, and another immediately beneath, for receiving and handling the ashes. The tube which failed was the fifth from one side and in the bottom row. The failure occurred about 30 in. from the front end and on the bottom side of the tube; the rupture was about 14 in. long. Part of the liberated steam forced its way down through the grate into the ash room while the balance came out into the fire room. An automatic non-return valve prevented the other boiler on the line from emptying its contents.

Of the two men on the firing floor one escaped by hurrying into the engine room, the doors of which were closed as quickly as possible. The other ran up a ladder and escaped into a tunnelway, suffering, however, a rather severe scalding before he could get out of range. A third man was at work in the ashroom and his only means of exit was a ladder which extended up through the fireroom to a floor above. He got part way up this ladder, but as conditions in the fireroom were as bad as in the ashroom he was overcome before he could reach safety. He was taken out as soon as help could reach him and died in a hospital a few hours later.

The opinion unanimously entertained by the boiler manufacturer, insurance company's inspector and the city boiler inspector is that the failure was caused by the presence of oil on the surface of the tube, preventing the water from conducting the heat away rapidly enough. The lips of the rupture were almost as sharp as a knife edge, indicating that the tube had been greatly elongated circumferentially before the break developed. The high ductility thus shown precludes suspicion of a defect in the tube itself.

The investigation following the accident brought out the fact that the oil separators apparently had not been operating effectively and that the presence of excessive oil in the boilers was known. One boiler had been thoroughly cleaned, the second was being cleaned, and the third, the one in which the tube failed, was to be cleaned as soon as possible.

While oil is by no means the only cause of tube failure, it certainly is an important one. And the regrettable feature of failures due to this cause is that they could all be avoided by the reasonable use of preventive means. A good filter to supplement the customary oil separators is a splendid insurance against trouble from oil getting into the boilers. Regular inspection of the apparatus provided for extracting the oil and, above all, thorough inspection of the interior surface of the boilers should be considered cardinal duties by every engineer. Because a tube cleaner does not gouge out great piles of scale when it is run through the tubes it does not necessarily follow that the boiler is in an economical and safe operating condition.

The fact that every tube failure does not result fatally encourages the impression that such failures are of but minor importance. And, perhaps, this point of view tends to heighten the danger through neglect of precaution, a condition resulting from contempt bred of familiarity.

Besides oil, another fruitful source of failure is inherent defects in the tube which ordinarily are undiscoverable. It is well known that a defective weld seldom shows on the surface. Besides, even when surface indications are present, the chances of discovery are small because a large proportion of the tubes are beyond the reach or vision of the inspector. Careful inspection at the shop, although unsatisfactory at best, is about the only precautionary means against accidents due to defectively welded tubes.

Although seamless tubes offer freedom from danger due to this source, they have the disadvantage of not always being of uniform thickness. With the cold-drawn tube, it is said that internal strains are produced which sometimes cause the tube to break simply when heated. Annealing practically eliminates this tendency.

Then, numerous tube failures occur without the slightest apparent cause. A welded tube will frequently break elsewhere than at the weld and without being corroded or weakened in any apparent manner and without evidence of overheating. Possibly these causes which cannot be foreseen tend to increase carelessness with regard to detecting and eliminating those that are discoverable. At any rate, there is no doubting that if all manufacturers and all plant operators would exercise greater precaution, the number of accidents would be markedly reduced. Their present frequency is appalling.

READERS WITH SOMETHING TO SAY

Cause of Defective Diagrams

The diagrams, Figs. 1 and 2, were taken from a 10x12-in. automatic engine, initial pressure 80 lb., and running 250 r.p.m. The scale of the indicator spring was 40.

After taking Fig. 1 the valve was taken out and filled with water, which showed that it leaked in the port or

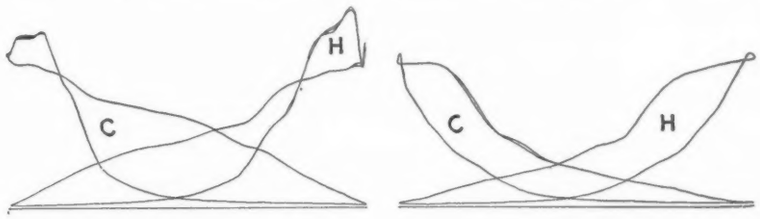


DIAGRAM FROM ENGINE WITH LEAKY VALVE

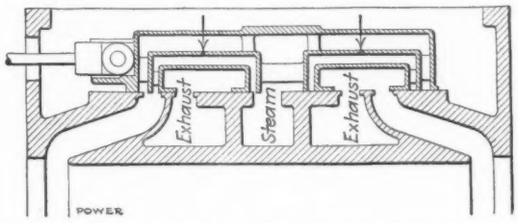


FIG. 3. TYPE OF VALVE THAT LEAKED

exhaust-steam passage. After a new valve was put in and the diagram, Fig. 2, taken, the back of the old valve was planed down. Large blow-holes were then visible, their location being indicated by the arrows, Fig. 3.

Grank Rapids, Mich. JAMES BOETSMA.

Repaired Scored Valves and Valve Seats

In the plant where I am employed we have an 11x14-in., high-speed, riding-cutoff, shaft-governor engine that has been in service 20 years, 20 hr. per day, 365 days per year, and is still giving good service.

Last winter this engine began to run at dangerous speeds. It was not safe to throw off the load unless we made a jump for the throttle at the same time. Indicator cards at no load showed late enough cutoff on the head end to cause the engine to run away.

After examining the governor adjustments, valve rod and rocker-arm and finding nothing wrong the steam chest was examined and a broken rib on the cutoff valve was found, which caused the valve to spring and the leakage of steam was sufficient to lift the valve from its seat and admit enough steam to the head end of the cylinder to produce a dangerous speed at light loads.

The broken valve was repaired by the oxyacetylene-welding process and scraped to a tight fit, after which the engine ran at normal speed.

One week later the main valve started a continual slamming. Upon examination of the valves, the other rib of the cutoff valve was found broken, due, no doubt, to the strains thrown upon it when the first rib broke. It was also found that chips from the broken rib had worked under the main valve and badly cut the valve face and seat. It took three days of hard work to scrape and fit the main valve and seat, and put in a new cutoff valve.

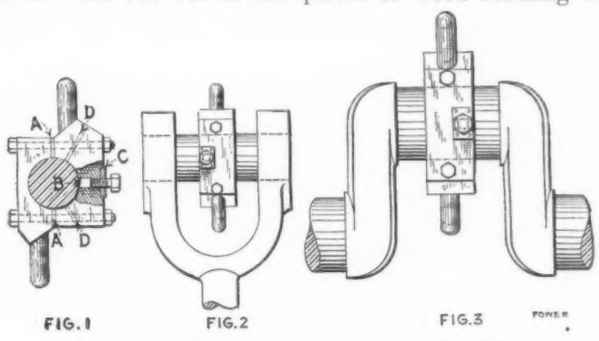
All engineers were cautioned to use plenty of cylinder oil until the freshly scraped valves and seats were worn to a polish. At this time the feeding of the lubricators bothered by slowing up, due to a very heavy grade of cylinder oil being used. Everything went smoothly for three days when a careless employee allowed the lubricators to slow up, or perhaps stop entirely, and the seats were again badly cut, the first intimation being a slamming of the main valve, due to steam rushing under it and lifting it from its seat.

It took three more days and part of three nights to again refit the main valve. This incident leads me to believe that there are many engines damaged by lack of sufficient cylinder oil, due to the neglect and carelessness of the men intrusted with their care.

Estherville, Iowa. E. C. SUTTON.

Truing Crankpin by Hand

A planer that is handy for quickly turning down pins that are worn out of round is shown in Fig. 1. This device is of great value when there is not time to send the pins to a machine shop. It is made of two pieces of hard wood bolted together, with $\frac{1}{16}$-in. liners inserted at *A* and bored to fit the largest place on the pin. The handles are cut out of the pieces of wood forming the



PLANER AND ITS APPLICATION TO PINS

blocks, and the length of the handles and width of the block must be made suitable for the job undertaken. A hole is cut in the block at B to take a ½- or ⅝-in. tool; square steel is preferred, and is to fit the hole snugly. A plate is set in the block at C drilled and tapped to fit a ½- or ⅝-in. setscrew and set nut to feed the tool.

Two oil-holes at *D* should have stoppers so that the oil cannot run out when the "planer" is turned. The blocks should be bolted together very solidly and just bind slightly on the pin. The tool should have a lip,

with very little clearance, and set down so that a very light cut is taken while plenty of oil is kept on the pin. Turning down a pin in this way is much easier and quicker than filing a pin and makes a good job if the liners are removed as occasion requires to keep the block close to the pin. We had six crosshead pins of the type shown in Fig. 2, which were badly worn, and at every port at which we stopped for a short time, one was taken down and turned off with one of these planers until all were in good condition. A splendid job was also done on the port high-pressure crankpin, Fig. 3, which was 16 in. in diameter. When turning these "planers" a slight pressure in the direction that the tool is to cut, will act as a feed, and with a little practice as smooth and nice a cut will be taken off as one would take on a lathe. Care must be taken to prevent too many shavings from getting under the wood. This can be prevented by having the tool near the edge and just enough offset on it so that it will cut at the edge of the block.

Philadelphia, Penn. K. D. GRANT.

Safety Valve Sticks

When we started our new plant we had one boiler in commission and we raised the pressure to 125 lb., at which the safety valve opened as desired. The valve would not close, however, until the steam pressure had decreased nearly 50 lb.

Investigation revealed that the bushing at the top of the valve through which the steam passed was too snug a fit and when the stem and bushing became heated by the steam, the stem became fast and stuck until it contracted enough to move. By making the stem hole in the bushing a trifle larger the trouble never recurred.

New Westminster, B. C. C. J. WILKE.

Preparing for a Peak Load

Upon taking charge of a new plant, I have found it was customary for the fireman to provide against a peak load by having a pile of coal handy and the fire clean of ash. Usually the draft is open, there is a thin fire on the grates and the boiler setting is allowed to become cool. These conditions are more generally found if the prevailing load is light.

Lowering of the boiler pressure, due to unusual demands for steam, is usually the first and only warning to the fireman that the peak load has been added.

He then throws open the fire-doors and fires heavy and, if the draft of steam continues, he finds the steam pressure continues to drop and his efforts are generally rewarded with little success in holding up the steam, unless he is relieved of some of the load long enough for the boiler-furnace walls to become properly heated for combustion to continue with temperature sufficient for the increased load.

Such conditions result in complaints of plant management and, in turn the firemen complain of shortage of boiler capacity. The time when peak loads may be expected is generally known and I believe I have met with considerable success in overcoming the difficulties in carrying heavy fires in anticipation of peak loads.

My method is first to provide a stack-damper gearing which is within convenient reach of the fireman for him to set the damper to different notches or points of opening, ascertain by flue-gas analysis the thickest fire that can be carried on the grates which will yield good efficiency with dampers wide open. Then, to meet a sudden demand for this full capacity, and meanwhile have the best combustion attainable, the firemen are instructed to keep their grates covered evenly with good solid fire of the thickness required for carrying the full overload, and regulate the draft according to the intermediate demands.

When the overload comes on, there is then no undue opening of fire-doors; no chilling effect of stoking green fuel—or, in fact, of stoking any green fuel for some time after the dampers have been thrown wide open, and regular firing for the peak load is begun and continued without interruption.

It is true that, after waiting for the peak load with dampers partly closed and carrying a thick fire, CO_2 may rise as high as 16 per cent., and there may be a rise in percentage of carbon monoxide and a drop in the efficiency. This, however, will be only temporary for, with most favorable conditions present, the highest efficiency is soon recovered.

Employing a CO_2 recorder during the regular working load, it is soon ascertained what rate of firing and opening of damper are most favorable to economy. Then by stoking and operating the damper appropriately for the rate of combustion necessary to keep up steam for the regular working load, and observing the indication of the CO_2 recorder, it is soon learned how to hold the regular load with best economy while thus prepared for a peak load, and while certainty and economy in carrying the peak load are assured, very fair economy may be thus attained for the intervals between peak loads.

Timmer, N. D. T. E. GRIFFITH.

Fire-Clay Furnace Arch

A furnace arch, which may help out in an emergency, or where the furnace fires are not driven hard, may be constructed of a mixture of cement and fire clay. Make a form of two boards of the desired height, fastened together at the ends with strips of wood. Cut two arch pieces to set on top of the side pieces, secure strips of wood 3 in. wide and as long as the form, and nail them on the arched pieces; then secure all in place, after cleaning out all old firebrick around the door at the boiler front. One end of the mould should butt against the boiler front, the bottom resting upon the dead plate.

Mix one pound of portland cement to each 10 lb. of fire clay, and have the mixture fairly stiff, but wet and properly mixed. Pack the mixture in firmly around the mould, having it at least 9 in. thick, if possible. Adding cement assists in a quick set.

The arch should stand at least one week before a slow fire is started. Do not try to remove the wooden form, but allow it to burn away. If a double-door arch is required, make two boxes, leaving space for the fire clay between them. I have known of arches built in this way to last for years. No skill is necessary in doing this job. The expansion will probably cause a few cracks to appear, but they will be no worse, and probably not so bad as those which form in firebrick arches.

Toronto, Ont., Can. JAMES E. NOBLE.

QUESTIONS BEFORE THE HOUSE

Heated Eccentric

Referring to the inquiry of H. L. R., in July 1 issue, I suppose there are eccentric straps that are not babbitted, but I have had no experience with them. If a babbitted eccentric strap runs hot enough to soften the babbitt so that it "runs" or slips, the oil grooves and holes are in danger of being covered by the slipping babbitt. This must be determined by an examination of the inside of the strap. If the babbitt has run into the grooves it should be dug out with a pointed scraper. Very often when babbitt gets that hot some of it slips onto the extreme heel of the strap and remains there, forming a rough spot on the strap heel that should be removed with a scraper before the eccentric strap is used again. So that if H. L. R. had a babbitted eccentric strap and it ran so hot as to slip the babbitt, he should do more than insert shims to remedy the trouble.

H. G. GIBSON.

Washington, D. C.

Thermal Loss in Four-Valve Engines

In his article "Corliss Versus Four-Valve Engine," on page 49, July 8, issue, C. R. McGahey states that "The thermal loss is greater in the four-valve engine, as the temperature of the cylinder is changed about twice as often as with the Corliss engine." This statement seems to me to be very much open to doubt, as the surface of the cylinder is much less in the four-valve engine than in the Corliss, and the fact that the alterations in temperature take place so rapidly must operate to reduce the losses as there is no time for any part of the cylinder except the thinnest skin to participate in these changes.

A. H. PUGH.

Cincinnati, Ohio.

Strain on Stay-Bolt

In the item, "Strain on Stay-Bolt," p. 834, June 10 issue, the elasticity of the bolt and boiler plate have been neglected. While the effects of elasticity are uncertain and to be on the right side of safety it may be customary to disregard elasticity in ordinary computations, an analysis of the conditions goes to show that in a case of this kind elasticity has considerable influence on the stresses both before and after subjecting the boiler to steam pressure. If the boiler stay consisted of a helical pull spring and the boiler sheet sprung when the original 8000-lb. strain was put on the stay, then when 10,000-lb. steam pressure comes against the plate, the stay would become farther elongated, but the boiler plate would spring back toward its original position; or in fact there might be sufficient strain in the stay to elongate it so much as to permit the plate to bulge outward beyond its normal shape and thus relieve the stay of all strain due to the outward spring of the plate. In any event the strain on the stay would be the strain due to the boiler pressure plus whatever strain might be created by the elasticity of the plate after the latter assumes a change of form corresponding to the increased length of stay.

Allowing that the original strain of 8000 lb. would produce a deflection in the plate of 0.031 in., and that for the same strain a stay of 1¼ in. diameter and about 16 ft. long had been elongated 0.029 in., and calling x = the total deflection of the plate after screwing up the outside nut, then when there is a pressure within the boiler of 100 lb. per sq. in., the total pressure supported would be

$$10 \times 10 \times 100 = 10{,}000 \ lb.,$$

and the total strain in the body of the stay would be

$$S = 10{,}000 + \left(\frac{x}{0.031} \ of \ 8000\right) \qquad (1)$$

Considered only with reference to the original strain in the body of the stay and the increase accompanying the increase of elongation amounting to $0.031 - x$, the total strain in the body of the stay would be

$$S = 8000 + \left(\frac{0.031 - x}{0.029} \ of \ 8000\right) \qquad (2)$$

As (1) equals (2) then

$$10{,}000 + \left(\frac{x}{0.031} \times 8000\right) = 8000 + \left(\frac{0.031 - x}{0.029} \times 8000\right)$$

from which it is found that $x = 0.0123$ in.

Hence from (1) the strain in the body of the stay is found to be

$$S = 10{,}000 + \frac{0.0123 \times 8000}{0.031} = 13{,}174 \ lb.$$

In the part of the stay between the inner and outer nut the length would be too short for any stretch so the stress between the nuts would be practically

$$13{,}174 + 2400 = 15{,}574 \ lb.$$

If the bolt had been very short so that there would have been little or no stretch, then the stress after pressure was applied in the body of the stay-bolt would have been very nearly 18,000 lb. and 20,400 lb. between the inner and the outer nuts; and in the other extreme case as where a heavy cylinder head is bolted up on a hard, unyielding gasket with comparatively light studs, the tension in the studs will be very little more than the fluid pressure.

H. D. FISHER.

Newton Highlands, Mass.

Test of Valve and Piston Tightness

We have read with interest, in the July 22 issue, page 121, the article entitled "Test of Valve and Piston Tightness." You will perhaps be interested to learn that in 1885 at the Exposition of Anvers our Bollinckx Corliss engine ran for six months with one cylinder head removed while producing a part of its power, without leaks, although a pressure of seven atmospheres was acting on the other side of the piston.

Brussels, Belgium. H. BOLLINCKX.

What Becomes of the Water

T. G. Thurston's letter on the above subject in the June 17 issue is noted. I do not know what becomes of the water in the sight-feed glass, but I think that if he will use glycerin instead of water, his troubles will entirely disappear and at the same time a much more regular feed of oil will be obtained. I have found it possible to reduce the quantity of cylinder oil used, owing to the more regular feed of small drops, caused by the greater difference in the specific gravities of water and oil and glycerin and oil. Anyone who once gives glycerin a thorough trial in sight glasses of lubricators will not readily go back to water.

E. R. PEARCE.

Rochdale, England.

Orsat or CO_2 Recorder?

When a correspondent in a recent issue of POWER states that he prefers to use an Orsat apparatus rather than a recording instrument for CO_2 analysis, inasmuch as an automatic CO_2 recorder leaves much to be desired, I cannot help thinking that this must be a personal view and not one generally taken by engineers versed in this interesting branch of engineering. On the other hand I should very much like to know which type of instrument he has had in use.

I have been using CO_2 recorders for about two years, and have rarely experienced any trouble with them. Whenever I have checked them up with the Orsat the results almost perfectly coincided.

Our instrument employs a large steel tank for absorbing the CO_2. Gas bubbles through the liquid, which is caustic potash of a specific gravity of 1.27. Besides absorption through bubbling there is a large surface with which the gases come in intimate contact. We use 2 lb. of caustic potash every month, which costs about 50c. The instrument is used day and night and makes about 20 analyses per hour. This charge lasts a full month, and we have found by means of frequent Orsat tests that after four weeks the record is just as correct as at the time the tank was filled.

There does not appear to be any defect in this part of the instrument, and then there is no continuous flow of gas through the caustic potash. If this were the case, a few days would be sufficient to thoroughly exhaust the solution, even a few hours as the correspondent states. The gas should pass through the instrument and the caustic potash at intervals, that is, only when the instrument analyzes. To get a correct analysis with the recorder, three minutes should be given, i.e., the speed of the recorder should not exceed 20 analyses per hour.

For several reasons, the Orsat is, no doubt, very useful, as it permits a complete analysis of the gases and should, therefore, be in every uptodate plant, whether a CO_2 recorder is used or not.

If 10 to 12 per cent. of CO_2 is maintained in the exit gases of any good furnace and no heavy smoke is being made, the engineer may be quite satisfied that he is making little if any CO, and therefore it is not necessary to frequently test the gases for CO and O. A CO analysis taken every now and then is of help to the engineer, but I do not think that it would pay the average boiler plant to install carbon-monoxide recorders, which are now on the market.

For producer gas a CO recorder would be of the greatest advantage. This instrument stands in exactly the same relationship to a producer plant as a CO_2 recorder to a boiler plant. In both cases the percentage of gas analyzed is to be kept as high as possible.

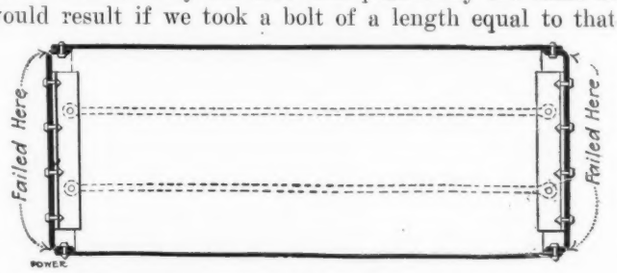
The correspondent mentioned the initial expense of a CO_2 recorder. We burned 20 tons of coal per 24 hours before the CO_2 recorder came to the plant, and we thought that we were doing good work. We have since decreased the coal consumption to 16 tons per 24 hours. During the four weeks which we had the instrument on trial the percentage of CO_2 was raised from 6 to 13 per cent., average, thus reducing the coal bill 10 per cent., which means a saving of about $10 per day. The instrument has paid for itself in less than five weeks, and consequently all are enthusiastic about it. We keep it in perfect working order and give it the attention which it no doubt deserves. We have realized its value as a fuel saver and as a general check over men and conditions.

F. D. HARGER.

New York City.

Why Did Hot-Water Tank Fail?

Answering the injury by R. Cederblom, page 139 of the July 22 issue, the tank failure was due to a concentration of the distortion caused by the pulsations and pressure in the tank at the points indicated by the arrows in Mr. Cederblom's drawing of the tank in question. The effect or action of these pulsations and pressure at the points indicated by the arrows is practically the same as would result if we took a bolt of a length equal to that



CONSTRUCTION OF TANK THAT FAILED

of the radius of the tank, and fastened one end of it firmly in a vise and continuously moved the opposite end back and forth through an arc equal to the movement of the center to the head of the tank in a longitudinal direction. All of the bending stresses would be concentrated close up to the jaws of the vise, and the bolt in time would break off at this point.

The deterioration in the case of the tank at the points of concentration of the stresses, due to pressure and pulsations is, however, hastened considerably by the action of the water in the tank. At these points, the hinge action, as we will call it, which allows of the movement of the head (and which made the angle irons necessary) produces little cracks. Water gets in these and promotes corrosion and pitting.

The tank very likely showed signs of distress long before the angle irons were installed, which was too late to remedy what had been done. In my judgment the angle irons were too short.

Fort Madison, Iowa. THOMAS C. ROBINSON.

INQUIRIES OF GENERAL INTEREST

Coke Heat Value—What is the calorific value of coke as compared with bituminous coal?

W. N. A.

It varies from 12,000 to 13,000 B.t.u. per lb., according to the coal from which it is derived and the method of coking the coal. A pound of average coke from Pocahontas coal has about 87 per cent. of the calorific value of a pound of Pocahontas bituminous coal.

Required Vacuum—Why does a steam turbine require a higher vacuum than a reciprocating engine?

F. E. K.

A steam turbine works more economically the higher the vacuum, but when a reciprocating engine works condensing the cooling effect on the cylinder walls of a vacuum greater than about 26 in. generally counteracts the advantages of the higher vacuum for reducing the back pressure.

Case-Hardening Pins—I am soon to put in new pins in the valve gear of our Corliss engines. How will I case-harden the pins?

J. C. J.

Melt about 2½ lb. of cyanide of potassium in a ladle. After the pins have been finished to a smooth surface heat them, one at a time, to a dull cherry red, and plunge them into the liquid cyanide. Each pin should remain in the liquid about one minute and then be plunged in clean water. The longer the pins remain in the cyanide the thicker the hardened wall of metal will be.

Try-Cock Blows Dry Steam—The water column of a high-pressure boiler has just been blown down showing no obstructions. When closed the glass fills, yet when a try-cock is opened only dry steam issues. What is the explanation?

J. S.

The water having just been changed in the column is at practically boiler temperature, which in a high-pressure boiler is considerably above the evaporation temperature at atmospheric pressure. Consequently, when the try-cock is opened, the pressure on the issuing water being suddenly released, it flashes into steam.

Changing Governors—If one had a slide-valve engine with a throttling governor and wished to use a shaft governor, what changes would have to be made to the valve?

F. E. K.

Unless the engine is already provided with some form of balanced slide valve capable of being moved with less friction than the ordinary slide valve, the valve would have to be changed to a balanced valve. In making such change the valve chest would probably have to be altered to accommodate the new type of valve. A shaft governor may be powerful enough to operate an ordinary slide valve, but such a combination is rarely satisfactory. The valve would need both inside and outside lap.

Chimney Capacity—What capacity has an iron stack 5 ft. in diameter and 135 ft. high? This one needs repairing. Will it do any harm to shorten it by removing the damaged section?

R. A. H.

The ordinary natural-draft capacity of this stack is 650 boiler-horsepower. Any shortening of the stack will lessen the draft in the boiler furnaces. The drafts due to different heights of stack are as the square roots of the heights. For instance, reducing the height to 121 ft., since the square root of 135 is 11.62 and the square root of 121 is 11, would reduce the capacity to

$$650 \times \frac{11}{11.62} = 615.3 \text{ hp.}$$

Constructing Blowoff Tank—What is the best material for a blowoff tank? Would it be safe to drain one into a 12-in. common tile drain having about 6 ft. fall in 1200 ft., leading to a creek? What is the best form for a blowoff tank?

S. F. G.

A blowoff tank being mainly for receiving blowoff water, and permitting it to cool off before being discharged into a sewer, should be large enough to hold about one-eighth the water of a boiler. It should be wrought iron or steel plate and strong enough to safely hold the greatest pressure carried by the boiler. In addition to an inlet for receiving the blowoff and an outlet for discharging it, it should have a vapor pipe carried up through the roof (always left open), a safety valve and a manhole for cleaning. Blowoff water should not be discharged into an earthen sewer pipe until it has cooled down to about 100 deg. F. as expansion from heat would soon cause the sewer to break up. (The fall of 6 ft. in 1200 would be sufficient for proper drainage if the pipe is carefully laid, i.e., with a uniform grade and with good even joints. The best form for a blowoff tank is cylindrical with standard bumped heads made of boiler plate.

Accelerating Time of Free Discharge—How is the interval of time computed within which a gas or liquid reaches its theoretical velocity of flow from an orifice under pressure, assuming the valve to open instantly?

M. W. C.

The time would be the same as that required for a body to fall in vacuo from the height of a column of gas required to produce the head or pressure under which discharge takes place. Knowing the weight of the gas or liquid per cubic foot the head in feet required to create a given pressure per square inch would be

$$h = \frac{\text{Pressure per sq.in.} \times 144}{\text{Wt. per cu.ft.}}$$

and, as the formula for falling bodies in which t = the time in seconds, is

$$t = \sqrt{\frac{2h}{g}}$$

then, as

$$g = 32.16,$$

the time in seconds to acquire the velocity due to the head would be:

$$t = \sqrt{\frac{2 \text{ (pressure per sq.in.} \times 144)}{32.16}}$$

Required Cylinder Diameter—What diameter of cylinder will be required to develop 50 hp. in an engine having a stroke of 4 ft., making 45 r.p.m. when working with a mean effective pressure of 30 lb.?

S. E.

Substituting the given values in the formula,

$$Hp = \frac{PLAN}{33{,}000}$$

where

P = Mean effective pressure in pounds per square inch;
L = Length of stroke in feet;
A = Area of piston in square inches;
N = Number of strokes per minute = twice the number of revolutions per minute;

then

$$50 = \frac{30 \times 4 \times A \times 90}{33{,}000}$$

or

$$A = \frac{50 \times 33{,}000}{30 \times 4 \times 90} = 152.77 \text{ sq.in.}$$

Since the area is equal to the square of the diameter multiplied by one-fourth of $\pi = 3.1416$ or

$$\frac{\pi}{4} = 0.7854$$

the diameter of the piston should be

$$\sqrt{\frac{152.77}{0.7854}} = 13.9 \text{ in.}$$

or practically 14 in.

Engine Alignment—How can it be determined whether or not the cylinder and guides are in line?

G. A. M.

After loosening the gland of the piston stuffing-box turn the engine over slowly. If the cylinder is not in line with the guides the gland will be moved to one side, or up or down.

ENGINEERS' STUDY COURSE

Evaporation—II

Steam Tables

In the first article it was shown that the boiling temperature of water is different for different pressures. Thus, at atmospheric pressure (14.7 lb. per sq.in. absolute, or zero gage) the boiling temperature is 212 deg. F., while at 150-lb. gage it is 365.9 deg. The higher the pressure, the higher the boiling temperature.

In addition, the latent heat, or the quantity of heat required to convert a pound of the water from its liquid to vaporous form, varies quite extensively with variation in pressure. Thus, the latent heat of steam at atmospheric pressure is 970.4 B.t.u. per pound, while at 150-lb. gage it is only 856.9 B.t.u., or more than 100 B.t.u. less per pound. The higher the pressure, the lower the latent heat.

The volume of a pound of steam varies greatly with variation in pressure. At atmospheric pressure 1 lb. of steam has a volume of 26.79 cu.ft., while at 150-lb. gage the volume is only 2.758 cu. ft., or only about one-tenth as much. The higher the pressure the smaller the volume per unit of weight. It is this characteristic of the steam that makes it suitable for use in engines, turbines, etc. The steam is generated at a high pressure with a small volume per unit of weight, then let into the cylinder or turbine stage where its pressure forces the piston ahead—provided the resistance of the piston is not greater than the pressure of the steam, which is the case when the engine is on dead center or when it is too heavily loaded.

As the pressure of the steam forces the piston forward, more room is created in the cylinder and the pressure is slightly relieved or lowered. As the pressure lowers, the steam must expand to fill the increased space because for every pressure there is a corresponding volume just the same as for every pressure there is a corresponding boiling temperature, latent heat, etc. And the relation of these quantities to each other never varies so long as steam is steam. They must fulfill Nature's laws, which are immutable—cannot be repealed or changed.

However, this action of steam in the cylinder of an engine is a little off the subject now occupying our attention, and a more thorough study of it will be offered in its proper turn later on.

Because the boiling temperature, latent heat, etc., are different for each different pressure, we have what are called the steam tables, or, to be more exact, tables of the properties of saturated steam. These are exceedingly convenient for finding the other factors when any one is known, and it behooves all who intend to continue on in power-plant study and work to become familiar with the tables.

A modified and condensed form of the latest accepted steam tables is presented herewith. The original tables were compiled by Professors Lionel S. Marks and Harvey N. Davis, and published by Longmans, Green & Co., through whose courtesy we are permitted to publish Table 1, herewith.

Gage and Absolute Pressure

In the first column of the table are given the vacuum and gage pressures; in the second, absolute pressures. In the first paragraph of this article you may have noticed that atmospheric pressure was given as 14.7 lb. per sq.in., absolute, or zero gage. This was done because in these modern days there are, unfortunately, two standards of pressure measurement. Gage pressure takes its name from the instrument commonly used for measuring boiler steam pressure. Now, the ordinary pressure gage used on a boiler does not indicate the total pressure actually existing inside the boiler. It only measures the difference between the pressure of the steam within the boiler and the pressure of the atmosphere without.

This is due to the construction of the gage, which consists principally of a curved hollow metal tube open at one end. The hollow interior of the tube connects at the open end with the interior of the boiler while the exterior of the tube is exposed to the pressure of the atmosphere. When the pressure acting on the inside of the tube is equal to the atmospheric pressure acting on the outside, the tube is in its normal position and the pointer on the dial of the gage, connected to the tube at the closed end, indicates zero on the scale. When the pressure within exceeds the atmospheric pressure without, the tube tends to lose its curve and straighten out. And as the closed end, to which the pointer is attached, is the only end free to move, the change in the position of the tube is all transmitted, through suitable mechanism, to the pointer. This swings away from the zero mark and points to the position on the scale corresponding with the pressure existing in the boiler over and above that of the atmosphere outside.

Absolute pressure means the total pressure actually existing in the space where the measurement is taken whether this be in a boiler, a condenser, in the open atmosphere or anywhere else. It does not take into account any outside pressure that may happen to be acting on the measuring gage or instrument. Hence, the zero point on the absolute-pressure scale is at absolute vacuum. If a whole boiler, pressure gage and all, were inclosed in a vacuum, the gage would then show absolute pressures because, there being absolutely no pressure outside, the difference between the inside and outside pressures would equal the total pressure actually existing inside the boiler.

The absolute-pressure system of measurement is the more accurate one because it is not dependent upon the more or less variable pressure of the atmosphere. An absolute-pressure gage is more complicated and expensive, however, than the ordinary gage used in boiler work, and, hence, far less popular. So, in actual steam-plant operation gage pressures are the ones mainly encountered. But gage pressures can easily be translated into absolute

pressures by adding the amount of atmospheric pressure existing at the location of the plant under consideration. Thus, at sea level, absolute pressure may be taken as gage pressure plus 14.7 lb. per square inch. At a higher altitude than sea level, the atmospheric pressure is less; hence, care must be used, in cases where the difference is appreciable, that the proper value be employed. For instance, at Denver the average atmospheric pressure is but 12.5 lb. per square inch. Consequently, the first column of Table 1 would be over 2 lb. out of the way and should not be used for accurate work. The thing to do in such cases is to translate into absolute pressures

TABLE I. PROPERTIES OF SATURATED STEAM

From Marks & Davis' Tables. Courtesy of Longmans, Green & Co.

			Total Heat Above 32° F.				
1	2	3	4	5	6	7	8
Vacuum In. of Mercury	Absolute Pressure, Lb. per Sq.In.	Temperature, Degrees Fahrenheit	Heat of the Liquid h B.t.u.	In the Steam H B.t.u.	Latent Heat $L = H - h$ B.t.u.	Volume Cu.Ft in 1 Lb. of Steam	Weight of 1 Cu.Ft. of Steam Lb.
27.88	1	101.83	69.8	1104.4	1034.6	333.0	0.00300
25.85	2	126.15	94.0	1115.0	1021.0	173.5	0.00576
23.81	3	141.52	109.4	1121.6	1012.3	118.5	0.00845
21.78	4	153.01	120.9	1126.5	1005.7	90.5	0.01107
19.74	5	162.28	130.1	1130.5	1000.3	73.33	0.01364
17.70	6	170.06	137.9	1133.7	995.8	61.89	0.01616
15.67	7	176.85	144.7	1136.5	991.8	53.56	0.01867
13.63	8	182.86	150.8	1139.0	988.2	47.27	0.02115
11.60	9	188.27	156.2	1141.1	985.0	42.36	0.02361
9.56	10	193.22	161.1	1143.1	982.0	38.38	0.02606
7.52	11	197.75	165.7	1144.9	979.2	35.10	0.02849
5.49	12	201.96	169.9	1146.5	976.6	32.36	0.03090
3.45	13	205.87	173.8	1148.0	974.2	30.03	0.03330
1.42	14	209.55	177.5	1149.4	971.9	28.02	0.03569
Lb. Gage Press.							
0	14.7	212.0	180.0	1150.4	970.4	26.79	0.03732
5.3	20	228.0	196.1	1156.2	960.0	20.08	0.04980
10.3	25	240.1	208.4	1160.4	952.0	16.30	0.0614
15.3	30	250.3	218.8	1163.9	945.1	13.74	0.0728
20.3	35	259.3	227.9	1166.8	938.9	11.89	0.0841
25.3	40	267.3	236.1	1169.4	933.3	10.49	0.0953
30.3	45	274.5	243.4	1171.6	928.2	9.39	0.1065
35.3	50	281.0	250.1	1173.6	923.5	8.51	0.1175
40.3	55	287.1	256.3	1175.4	919.0	7.78	0.1285
45.3	60	292.7	262.1	1177.0	914.9	7.17	0.1394
50.3	65	298.0	267.5	1178.5	911.0	6.65	0.1503
55.3	70	302.9	272.6	1179.8	907.2	6.20	0.1612
60.3	75	307.6	277.4	1181.1	903.7	5.81	0.1721
65.3	80	312.0	282.0	1182.3	900.3	5.47	0.1829
70.3	85	316.3	286.3	1183.4	897.1	5.16	0.1937
75.3	90	320.3	290.5	1184.4	893.9	4.89	0.2044
80.3	95	324.1	294 5	1185.4	890.9	4.65	0.2151
85.3	100	327.8	298.3	1186.3	888.0	4.429	0.2258
90.3	105	331.4	302.0	1187.2	885.2	4.230	0.2365
95.3	110	334.8	305.5	1188.0	882.5	4.047	0.2472
100.3	115	338.1	309.0	1188.8	879.8	3.880	0.2577
105.3	120	341.3	312.3	1189.6	877.2	3.726	0.2683
110.3	125	344.4	315.5	1190.3	874.7	3.583	0.2791
115.3	130	347.4	318.6	1191.0	872.3	3.452	0.2897
120.3	135	350.3	321.7	1191.6	869.9	3.331	0.3002
125.3	140	353.1	324.6	1192.2	867.6	3.219	0.3107
130.3	145	355.8	327.4	1192.8	865.4	3.112	0.3213
135.3	150	358.5	330.2	1193.4	863.2	3.012	0.3320
140.3	155	361.0	332.9	1194.0	861.0	2.920	0.3425
145.3	160	363.6	335.6	1194.5	858.8	2.834	0.3529
150.3	165	366.0	338.2	1195.0	856.8	2.753	0.3633
155.3	170	368.5	340.7	1195.4	854.7	2.675	0.3738
160.3	175	370.8	343.2	1195.9	852.7	2.602	0.3843
165.3	180	373.1	345.6	1196.4	850.8	2.533	0.3948
175.3	190	377.6	350.4	1197.3	846.9	2.406	0.4157
185.3	200	381.9	354.9	1198.1	843.2	2.290	0.437
195.3	210	386.0	359.2	1198.8	839.6	2.187	0.457
200.3	215	388.0	361.4	1199.2	837.9	2.138	0.468

and use the second column. For most ordinary purposes, however, the errors caused are hardly important enough to warrant any large amount of extra work.

The third column of Table 1 gives the temperature of the steam at various pressures. This temperature is also the boiling temperature of water under the corresponding pressure, as was carefully explained last week.

Heat of the Liquid

In the fourth column is given the heat of the liquid, or, as it is sometimes called, the heat in the water. The figures in this column represent the number of B.t.u. required to raise the temperature of 1 lb. of water from 32 deg. to the boiling temperature at the pressure given. Thus, at atmospheric pressure or zero, gage, the heat of the liquid is 180 B.t.u. This can be easily checked from the knowledge gained from previous lessons. It was learned by definition that it takes 1 B.t.u. to raise the temperature of 1 lb. of water 1 deg. Then, as there are 212 — 32 = 180 deg. difference between 32 and the boiling point, it must require 180 × 1 = 180 B.t.u. to raise 1 lb. of water from 32 deg. to the boiling temperature at atmospheric pressure.

As the pressure grows higher, the heat of the liquid does not exactly correspond with the number of degrees difference between 32 and the boiling point. Thus, at 35.3-lb. gage, or 50-lb., absolute, pressure, the number of B.t.u. required to raise the temperature of 1 lb. of water from 32 deg. to the boiling point (the heat of the liquid) is 1.1 greater than the number of degrees between those two points. This is because the heat required to raise the temperature of 1 lb. of water 1 deg. increases gradually as the pressure increases above 14.7 lb. per square inch.

In the sixth column of Table 1 are given the values of latent heat of steam at the various pressures.

Total Heat in Steam

The figures in column 5 are the sums of the figures in columns 4 and 6 and they show the total heat contained in 1 lb. of steam above the temperature of 32 deg.

It may be a source of wonder to some why columns 4 and 5 are headed "Total Heat Above 32 Deg., F." The explanation is this:

Every substance, no matter what its temperature, contains some heat. We think of a piece of ice as a pretty cold chunk of solid water and would hardly suspect, on first thought, that it could have any heat concealed about it. Yet, a pound of ice just at the freezing point (32 deg.) possesses 16 B.t.u. more than a pound at zero temperature. Ice may possess different temperatures just the same as water, steel or steam. Then, ice at zero is certainly colder than ice at 32 deg. and, *vice versa*, ice at 32 deg. must be warmer than ice at zero, and hence it must possess more heat.

In fact, no matter how cold you may make a substance, it still must possess some heat. Suppose, you refrigerated a piece of ice until its temperature went down to —75 deg., in all 107 deg. below the normal freezing point of water. That would be pretty cold, wouldn't it? Yet that ice could be refrigerated still more, say, to —100 deg., showing that even at —75 deg. it hadn't yet lost all the heat it possessed.

Man has not yet discovered just what the absolutely lowest temperature is. He has succeeded in obtaining artificially some very low degrees, but he has never reached the lowest limit because his apparatus fails first.

Then, in view of the fact that we do not know at just what temperature the point of complete lack of heat exists, we must establish a "base" line to work from when we talk of or deal with quantities involving "total" heat. In dealing with steam, this base line is the freezing point of water under atmospheric pressure, or 32 deg. F. Thus, the total heat of the liquid or in the water is the heat that must be imparted to 1 lb. of water in order to raise its temperature from 32 deg. to the boiling point. And the total heat in the steam is this quantity plus the latent heat.

Column 7 gives the volume of 1 lb. of steam in cubic feet and column 8 the weight of 1 cu.ft. in pounds.

OVER THE SPILLWAY

JUST JESTS, JABS, JOSHES AND JUMBLES

The surest thing you know is that if you go to the Springfield convention next week, you'll have the time of your young life. Are you going?

❖

"We must trust each other or the world will go wrong," says "Leslie's Weekly." This is a very pretty sentiment, but great Cæsar's spook! not everybody's doing it. Right now, who is trusting you or me? I trust you're well; you may trust I'll croak, which is a sentiment after a kind. To prove the trust you have in me, will you slip me five bucks? And you say, "The world has indeed gone wrong!" That's what I mean, exactly.

❖

"Once a stoker, he died worth millions."—Headline.

Why make all this daily-press noise about it? It's a fine thing to have risen (or fallen, if you prefer it) from a stoker to a millionaire, but do you know any stoker today who would change places with the dead millionaire? Not on your favorite scoop, you wouldn't!

❖

Pythias had his Damon, but Pyth didn't have anything on Springfield, which has Walter Damon. Walt came to Springfield 22 years ago and started in as a wheelbarrow engineer in the boiler room of the same plant in which he is today its chief engineer; and it's the largest plant in that city. He's also chairman of the local convention committee. This means he'll give you the city and everything in it before he'll let you go home dissatisfied. Another good reason for going to the convention.

❖

"Since Adam's time there have been changes," says "Printer's Ink." It takes some wise little guy to discover such a deep-hidden fact. Adam is a sore topic with us; we blame him for having wished on us a long life of toil and travail we have never as yet got accustomed to.

❖

This modern Babylon, New York City, will have a real coroner if International President Timothy Healy (elected eight times) of the Eccentric Firemen is elected on the city ticket this fall. If Tim sits on the corpse, it'll get full justice. Tim is a live one, and we pity the divil who killed the "corp!" He's dead already, meaning the malefactor as well as the corp. The only thing Tim ever ran from is his friends; offices, and his enemies, he runs for, and gets them. As a coroner, he looks like a dead winner!

❖

Civil Engineer or Dentist?—"Engineering News."

Our contemporary reprints a letter advising a young man to learn dentistry rather than civil engineering; it says the emoluments are greater. To our mind, it takes a big pull to get anywhere with either of these professions. Personally, we, too, favor the dentistry; it's more filling; it's a drawing business; you get in with the upper set by gum! and it's painless—to the dentist. Your clients look at you with open mouth at your ability. It's a nerve-killing business, but it pays.

❖

"Have you ever realized the value of expressed appreciation as an aid in the successful handling of your employees?" asks "Coal Age." As an employer, we have had but small concern. As an employee, we've several times capered on our hind legs, because the Old Man expressed his appreciation of our well doing. It's good dope; it tickles us all, and it costs our bosses nothing, unless they have an over-rated sense of their own importance and aloofness.

❖

Engine running on buttermilk? Yep, at the recent Gas Power Show in Kansas City, an exhibitor displayed a sign reading: "See the ——— Engine Running on Buttermilk." A small gasoline engine, running at full speed, was supported on four bottles of buttermilk. One of our well-wishers made us the goat on this tale. We hope it's true.

❖

The musical-instrument trade has not been affected by the war in Southeastern Europe, says a consular report. That's just it; some of these instruments stimulate a war. There can't be peace in the hearing of a wheezy concertina or a squawking fiddle; either would start a dog or cat fight.

Lunkenheimer Monitor Automatic Water Gage

This water-gage is made in two patterns, intended for 200- and 300-lb. working pressures, respectively. They are made either right or left hand, as desired, to facilitate operation.

Should the gage-glass break, ball check valves automatically seat themselves, owing to the rush of steam and water on one side and the lack of pressure on the other. They prevent the escape of steam and water and permit the safe closing of the hand-operated valves before renewing the glass.

To renew the glass, it is only necessary to loosen the stuffing-boxes, take off the cap and substitute a new glass, after which the stuffing-boxes are tightened and the cap replaced.

Particular care has been exercised in the design of the gage to facilitate cleaning, and access can be readily had to any part by the removal of plugs. By removing the bottom plug and opening the regrinding valves to their greatest extent, a rod can be inserted through the body and tail pieces, and any sediment that might have collected in or around the entrance of the tailpieces can be removed. By unscrewing other plugs the check balls will fall from the body, as they rest on inclined surfaces.

It has been the practice to attach both valve pulleys together by means of a chain or cord pinned to the pulleys, so that the proper closing of one depended entirely on the closing of the other. While in some cases this method was satisfactory, unless great care was exercised in pinning the chain to the pulleys, or after the valves had been reground several times, one of the valves would not seat properly. To overcome this difficulty the Lunkenheimer Co., Cincinnati, Ohio, have arranged it so that both valves can be made to seat independently of each other. This arrangement consists of a block pulley operating over a chain, which is pinned to both the upper and lower pulleys. Should one of the valves become closed before the other, a continued pull on the block chain will close it.

The valves are constructed to be reground when worn. The valve-seat opening is large and a free and unobstructed passage for the water and steam is insured.

The gage cannot show a false level, with free pipe connections, as the ball checks are so constructed that unless the glass breaks, they will, owing to their weight and position, fall away from their seats.

❖

Endura Sheet Packing

A new sheet packing, known as Endura, is made of a vegetable fibre and so treated that it resists the softening and rotting effects of oil and water (hot or cold), acids, benzine or gasoline, coal-tar, brine, ammonia, etc., and increases its toughness and tensile strength, without adding greatly to the weight of the fibre sheet. It is not recommended for steam or dry-heat conditions, but for use under moist conditions. It is also suitable for pump packing where the water contains acids and is said to give excellent results with water containing 4 per cent. sulphuric acid.

This packing is manufactured by the Endura Manufacturing Co., 6301 Eastwick Ave., Philadelphia, Penn.

Cleaning and Inspecting Water-Tube Boilers

By F. T. Ravlin

When about to clean a boiler it should be cut off from the steam header, allowed to cool, given proper air vent and the blowoff valve opened to drain out all water. The manhole plates in the steam and mud drums and the hand-hole plates should be removed and the blowoff valves closed after washing out.

A hose should be used with 100 lb. water pressure, if possible, to wash out the drums thoroughly, and all remaining scale should be removed with scrapers. The inside feed-water pipe should be removed, thoroughly cleaned and replaced and the water-column connections and gage cocks inspected. After removing the bottom water-glass bonnet, the connection to the boiler should be rodded out. With all caps on the upper ends of the tubes removed, an air- or steam-driven rotary cleaner under not less than 75 lb. pressure, should be applied to each tube for not less than three or four minutes, and more when the scale is thick.

The cleaner should be fed in at a uniform speed and not allowed to remain in one place while in operation, as the tube is likely to be injured by the cutter. A stream of water should be run into the tube to wash out the scale ahead of the cutter. After boring the tubes by placing a light at the front end of each, they may be carefully inspected from the rear end.

When the boiler is not badly scaled only the lower row of caps and a row running diagonally across the headers from each corner on the rear end, need be opened for inspection, thus saving time in cleaning. The caps and bolts should be cleaned thoroughly and all inside tube plates thoroughly inspected, and if sprung or cracked around the bolt holes, replaced with new ones. Ground-joint caps should be refitted by rubbing the cap with a circular motion, on the header seat, using a suitable grinding compound. Care should be exercised in replacing each tube plate to see that it fits onto its seat correctly. A mixture of black lead and engine oil should be used on the cap-bolt threads.

Under no consideration must a wrench over 24 in. long be used to tighten up the cap nuts. No leak should be allowed, as the steel will cut out in a short time.

Gaskets should be used on manhole and mud-drum plates, care being taken to thoroughly coat them with oil and black lead on the outer face after they have been fitted carefully on the plates. The plates should be inserted in the drums and lined up properly with the openings, the crabs put on and the bolts drawn up tight.

After filling the boiler with hot water and testing with the pressure carried on the feed-water line, all joints should be examined for leaks. If defects are found, the boiler should be blown down to the desired level and the defects remedied.

Next the baffles should be examined and repaired and the tubes swept and thoroughly inspected, especially over the fire. If any of the tubes are found with knuckles or cracks they should be replaced with new ones. Then the bridge-wall and combustion chamber should be cleaned, and the furnace walls and grates examined, as well as the drum plates, inside and out, to see that all rivets are tight, and that no pitting or corrosion has occurred on any part of the shell.

Mud-drum nipples are apt to rapidly deteriorate and should receive close attention and be tested with a small hammer. When the boiler is under steam it should be seen that the safety valve releases at the proper pressure. After the boiler is ready and put into service it should be blown down to one gage of water, the damper opened slightly and the fire started. It is advisable to clean the outside of the headers and mud-drum nipples on both sides, and paint them with red mineral paint each time the boiler is washed out.

Proposed Smoke Rules for Cincinnati

The report of the Boiler, Furnace and Stack Code Commission appointed by the Mayor of Cincinnati early this year was recently handed in, and it is expected that the Council will pass the recommendations, making them a part of the present smoke ordinance.

Among the recommendations are the following important items:

The Smoke Inspection Department shall supervise the construction of steam-boiler furnaces, and require alterations of furnaces where necessary.

All plans and specifications for boilers and furnaces except such as are for installation in private residences or in apartments having less than five families, shall be submitted to the Smoke Inspection Department, and a permit received from that department before work of installation is begun.

No furnace shall be finally put into operation until the Chief Smoke Inspector has issued a certificate of approval.

The Chief Inspector shall have no authority to prescribe to any consumer, or to recommend any particular brand of fuel or fuel from any particular mine, but he may advise as to the particular properties of the fuel best adapted to any particular installation.

The permissible density of smoke shall not be darker than Scale No. 1, which scale has for a basis four thicknesses of gray glass, one thickness of which will cut off 60 per cent. of the light from a flame having the power of 16 candles.

Each boiler with more than 1500 sq.ft. of heating surface, using coal as fuel shall be provided with an automatic mechanical stoker.

All hand-fired furnaces on boilers carrying more than 20 lb. steam pressure shall be provided with steam-air jets, there being one jet for each 250 sq.ft. of heating surface but not less than three jets to any one furnace.

The minimum distance between the grate and tubes of hand-fired horizontal water-tube boilers shall not be less than 36 in. Boilers of this type and of the vertical type when they are hand-fired must have an extension furnace. No stack for a stationary boiler shall be less than 90 ft. and 10 ft. shall be added for every right-angle bend in the breeching. Higher stacks than given by this rule are recommended.

Stacks of boilers used in the repair of old buildings or in the construction of new ones must extend to the top-most story under construction.

For more details concerning the construction of furnaces and location of stokers, write the Smoke Inspection Department. This department would undoubtedly gladly supply such information to boiler and stoker manufacturers.

Editorial comment on these proposed rules is made on page 339 of this issue.

N. A. S. E. Springfield Program

The program for the thirty-first national convention of the National Association of Stationary Engineers, to be held in Springfield, Mass., on Sept. 8 to 13, is as follows:

MONDAY, SEPT. 8

9:00 a.m. to 9:00 p.m.—Reception of delegates and visitors at the trains throughout the day; escorted by the band. Registration and distribution of badges at the Auditorium.

8:00 p.m.—Informal reception by the national officers in the Auditorium's Mahogany Room.

9:00 p.m.—Mechanical Exhibition, in Exhibition Hall. Opened by National President John McGrath and Vice-President James R. Coe.

TUESDAY, SEPT. 9

10:30 a.m.—Opening exercises of convention in Court Sq. Theater. Called to order by W. H. Damon, chairman of the Local Committee.

Convention Proceedings

Invocation—The Rev. B. D. Hahn, pastor of the State Baptist Church.
Address of Welcome—Mayor John F. Denison.
Response—National President John F. McGrath.
Address—Charles T. Bosworth, the Springfield Board of Trade.
Response—Vice-President James R. Coe.
Address—Stewart Anderson, president the Publicity Club.
Response—Past National President E. H. Kearney.
10:30 a.m.—Convention opened by National President John F. McGrath.
Appointment of Convention Committee.
Report of Credentials Committee.
Official photograph immediately after adjournment. Recess.
2:00 p.m.—Session in Grand Army Hall. Reports of national officers, license committee, educational committee, committee on history. Annual meeting of life and accident department following adjournment of session.
2:00 p.m.—Opening exercises of Ladies' Auxiliary. Called to order by Mrs. Carrie Bremmer.
Address of Welcome—Mayor Denison. Response—Past President Mrs. Louise Mullen.
3:30 p.m.—Tea and musicale in Mahogany Room. Ladies attending the convention are invited.
8:30 p.m.—Band concert in the Auditorium.
10 p.m.—Smoker and entertainment at Hibernian Hall.

WEDNESDAY, SEPT. 10.

9:30 a.m.—Regular session. Visit to Chapman Valve Co.
1:00 p.m.—Boats and trolley car pleasure trip leave for Riverside Park. Includes a clambake; athletic sports; annual ball game of Engineers and Supply Men. Prizes donated by the Exhibitors' Association. Concert and dancing afternoon and evening. Fireworks at Park in evening.

THURSDAY, SEPT. 11

9:30 a.m.—Business at this session: Reports of committees; discussion of welfare work, license legislation, state associations; convention work; methods of propagation; educational features; entertainment programs.
10:00 a.m.—Regular session, Ladies' Auxiliary.
11:00 a.m.—Annual memorial service.
2:00 p.m.—Report of board of trustees of "National Engineer." Lecture and discussion of welfare work.
2:30 p.m.—Ladies Day at Exhibition Hall. Souvenirs given this afternoon only.
8:00 p.m.—Entertainment at Auditorium by Exhibitors Association.

FRIDAY, SEPT. 12

9:30 a.m.—Regular session. Committee reports and unfinished business. Selection of 1914 convention city. Election of officers.
1:00 p.m.—Trolley trip to Mount Tom for the ladies.
8:30 p.m.—Installation of officers and presentations, at Hotel Kimball.
9:00 p.m.—Grand ball at Hotel Kimball.

SATURDAY, SEPT. 13

Delegates and visitors will be taken to the points of interest around Springfield.

NEW PUBLICATIONS

PRACTICAL GEOMETRY AND GRAPHICS. By Bates and Charlesworth. Published by D. Van Nostrand Co., New York. Cloth; 616 pages, 5x7½ in.; illustrated and indexed. Price, $2 net.

The authors have written this work with the object of giving a volume to engineers, architects, draftsmen, etc., that they could use in their work and to meet the demands of students in technical schools.

There are three sections to the book: (1) Plane Geometry; (2) Graphics; (3) Descriptive Geometry. In many respects the book is similar to the many books on this subject which are available in the market, except that the chapter on loci and loci methods of solving problems and the chapters on conics, graphics and vectors are more extensive than is found in most books. Numerous diagrams are given to assist the student in grasping a knowledge of the subjects in hand.

PRACTICAL MATHEMATICS FOR TECHNICAL STUDENTS. By Bates and Charlesworth. Published by D. Van Nostrand Co., New York. Cloth; 513 pages, 5x7½ in.; illustrations; tables and indexed. Price, $1.50 net.

This book was written for those who do not combine instruction in practical mathematics with practical geometry, and who have been unable to adopt the authors' existing textbooks, "Practical Mathematics and Geometry," published in 1910.

No previous knowledge of mathematics is assumed and the work is intended to cover a two or three years' course. Although the treatment of the various branches of mathematics is rather brief on account of the size of the book, the needs of the student who must work unaided by a teacher have been considered. The book begins with simple examples in the lower mathematics and treats all the numerous branches, including exercises in the use of squared paper, and ends with chapters on trigonometry and calculus. The practical man who is normally intelligent and who must teach himself the branches of mathematics needed in his work ought to make reasonably good progress with this book providing he is persistent.

BOOKS RECEIVED

ELECTRICITY FOR THE FARM AND HOME. By Frank Koester. Sturgis & Walton Co., 7½x5¼ in. Cloth. 279 pages; illustrated. Price, $1, net.

THE SCIENCE OF BURNING LIQUID FUEL. By William Newton Best. 9¼x6¼. Cloth; illustrated; 159 pages. Price, $2.

FACTORY LIGHTING. By Clarence E. Clewell. McGraw-Hill Book Co. 9½x6½ in. Cloth; 161 pages; illustrated. Price, $2, net.

SOCIETY NOTES

The second annual outing and dinner of the Newark, N. J., Engineers Blue Club was held at Olympic Park, Newark, on Sunday, Aug. 24. The dinner was pronounced the best that had ever been given by the engineers in the East. The "Bunch" and the Engineers played a tie game of ball, the score being 5 to 5.

The second annual National Gas Power Show, given by the National Gas Engine Association, was held in Convention Hall, Kansas City, Mo., on Aug. 16 to 23. Over seventy exhibits were made and while the majority of the displays were of small engines for domestic and agricultural uses, several manufacturers of power engines were represented.

PERSONALS

W. E. Sanders, formerly with the Tagliabue Manufacturing Co., New York City, is associated with the Paul B. Huyette Co., Philadelphia, as mechanical engineer.

Lawrence W. Cody, formerly chief electrical engineer of the Browning Engineering Co., Cleveland, Ohio, has opened an office at 1557 Robinwood Ave., Lakewood, Ohio, and is engaged in consulting and designing work.

George Best, president of the Best Manufacturing Co. for 12 years, has severed his connection with that company and, with his son, George H. Best, has organized the Best Pipe Engineering & Supply Co., with office at 3026 Liberty Ave., Pittsburgh, Penn., to engage in the manufacture and sale of pipe, valves, fittings, etc., and design piping systems for all purposes.

Charles H. Moyer, for 20 years New York manager and chief traveling representative of the George V. Cresson Co., Philadelphia, and in the last few months of its successor, the Cresson-Morris Co., has resigned his position. Mr. Moyer, who is widely known as a specialist in power-transmission machinery, was connected with the George V. Cresson Co. since boyhood and held various positions at the works before opening the New York office. He contemplates going into business as a special engineering representative and manufacturers' agent with an office at 90 West St., New York City.

Nicholas F. Brady, son of the late Anthony N. Brady, has succeeded his father as president of the Edison Electric Illuminating Co., of Brooklyn. J. C. Brady, another son, has been made a director and vice-president to fill the vacancy created by the elevation of Nicholas F. Brady.